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Railway
Mechanical Engineer

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November - 1933

T. & P. Receives Light-Weight Stainless-Steel Passenger Train

Two cars contain 15-ft. mail compartment, 33-ft. baggage room, and seats for 76 passengers. The total weight is about 104,000 lb. and power plant develops 48 hp.

FOLLOWING a number of demonstration trips on October 23, a light-weight two-car train of Shot-welded stainless-steel construction left the plant of the builder, the Edward G. Budd Manufacturing Company, Philadelphia, Pa., under its own power for delivery to the Texas & Pacific. When the train arrives at its home rails it will be placed in service on a 250-mile passenger run between Fort Worth, Tex., and Texarkana, Ark., making a round trip of approximately 500 miles daily on a seven-day schedule. This becomes the first installation of a completely equipped train of the new light-weight construction, with passenger, baggage and mail facilities, to be placed in long-distance main-line service.

The train consists of two cars, the first of which is 69 ft. 7 in. long overall. It contains the power plant and a 15-ft. mail and 33-ft. baggage and express compartment. This car is carried on two four-wheel trucks of conventional design, with steel wheels. The second car, which is 69 ft. 4 in. long, has seats for 76 persons in three compartments. At the front end of the car is a 12-ft. compartment for colored passengers, with seats for 16. Behind this are the lavatories, one for the colored passengers and one for the white passengers. The main passenger compartment, 34 ft. 9 in. in length, lies to the rear of the entrance vestibule and seats 48. Behind this, at the rear end of the car, is the smoking-observation compartment, with seats for 12. This car is carried on two pneumatic tired eight-wheel trucks of Budd design.

Double seats, furnished by Hale & Kilburn, are non-reversible, with individual backs and comfortable upholstery, including air-check seat cushions. The aisle arms are covered with upholstered pads. The upholstering is in blue leather which matches the window curtains in shade. The car is fitted with parcel racks and coat hooks along the sides over the windows. The cars are equipped for complete air-conditioning of the passenger compartments, including refrigeration for air cooling in the summer and a steam boiler for heating in the winter. The air-conditioning system is of special light-weight design of Westinghouse-Sturtevant manufacture. The train, completely equipped and with supplies, ready to run, weighs about 104,000 lb., of which

Texas & Pacific light-weight stainless-steel passenger train

The heating boiler and master control panel in the front end of the baggage compartment

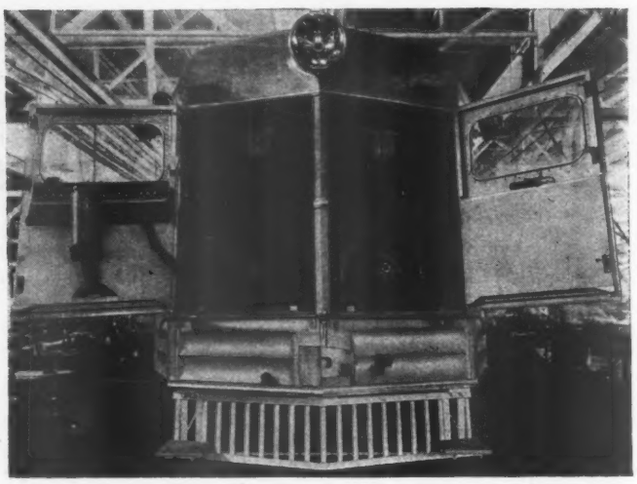
the power car accounts for 80,000 lb. and the trailer 24,000 lb.

The Stainless Steel Structures

With the exception of the interior finish and the floors in the baggage and mail compartments of the power unit and some of the interior finish of the passenger coach, the car bodies are constructed of thin gage stainless steel by the Budd system of specially formed structural sections and the controlled-energy method of spot welding known as Shotwelding. In the first car built by the Budd Manufacturing Company early in 1932 the main load-carrying members were built in the form of Pratt trusses, 23 in. deep. These trusses extended below the floor member and formed the side members of the underframe. In the body design of the T. & P. cars the truss has been continued upward to the belt rail below the windows. The windows are so spaced as to provide dead panels between them of sufficient width to permit the insertion of diagonals from the belt rail to the top window rail, thus stiffening the sides against shearing stresses and bringing the entire side and roof structure of the car into action with the Pratt side truss proper.

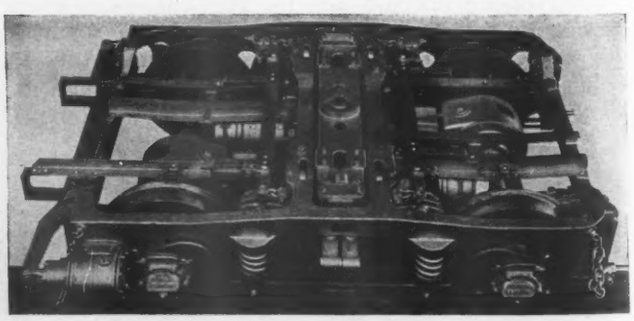
The end construction below the floor is developed in the form of a stiff horizontal truss which distributes buffing and pulling shocks over the entire underframe and side structure. Throughout the design, in fact, an effort has been made to provide a structure which will act under all loads as a balanced unit. The total deflection due to combined live and dead loads is $\frac{3}{8}$ in. in the front, or power, car, and $\frac{3}{16}$ in. in the rear car.

The sides below the windows are closed with the concave or corrugated sheets of .020-in. material characteristic of previous cars built by this company. The sides between the windows, and the roofs, are closed with sheets of stainless steel of the same thickness which are corrugated to a much finer pitch. To provide additional stiffness in the roof structure over the side-door openings additional purlines are built in and the corrugated roof sheets are stiffened by the insertion of a flat sheet of stainless steel .040 in. in thickness between them and the roof frame, extending completely across the car. These sheets are welded to the carlines, the purlines and the corrugations of the outside roof sheets.



Front doors open on the power car showing accessibility of the power plant

Interior of the passenger coach, looking toward the observation-smoking compartment



The power truck

At approximately the middle of the large passenger compartment of the passenger-carrying car a deep U-section stiffening member has been extended around the interior from the floor on one side, up across the ceiling and down to the floor on the other side. This feature, which is shown in one of the illustrations, was

provided to break up the unsupported roof structure into two short panels with high critical vibratory periods, and thus prevent a harmonic vibration of relatively low frequency from being set up in the long roof panel by rail-joint reactions at critical speeds within the operating range.

The floor of the passenger car is finished with a cork tile surface laid on a supporting floor of stainless steel construction. In the baggage and mail compartments the floors are ⅞-in. tongue and groove maple with a cork tile covering in the mail compartment.

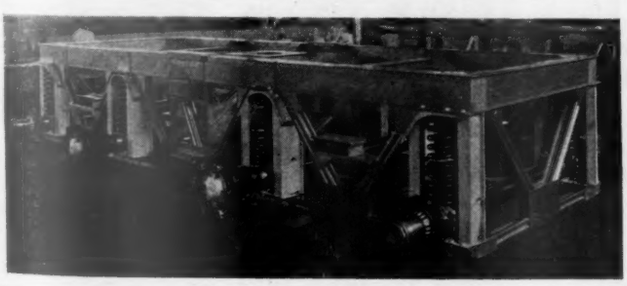
Both cars are insulated with Alfol throughout. In the passenger car the ceiling is finished in Masonite's tempered Presdwood headlining finished in special light-reflecting paint. The side lining is insulated Formica,

Air-conditioning evaporator and return air ducts in the rear end of the baggage compartment

finished in two tones of gray. The windows are of polished plate, shatter-proof glass, permanently closed.

The baggage car is finished with Masonite Presdwood headlining painted with a gloss white lacquer in all compartments. The engineroom and mail compartments have No. 16 gage steel side linings, while that in the baggage compartment is of galvanized sheet steel, with corrugations of 1¼-in. pitch.

The cars are equipped with a complete air-conditioning system which is carried in the baggage car. A flexible duct over the adjoining end doors serves to convey conditioned air, cooled in summer and heated in winter, from the unit in the baggage car to the passenger coach for distribution through the central duct below the ceiling. Similar ducts on either side of the doors con-



The passenger-coach truck frame

vey the recirculated air back to the unit in the baggage car. A 300-lb.-per-hour low-pressure steam boiler, furnished by the Vapor Car Heating Company, is installed in the baggage car. This boiler is oil fired with automatic controls, and supplies steam directly to fin-tube radiators in the mail and baggage compartments and to the heat exchanger in the air-conditioning system.

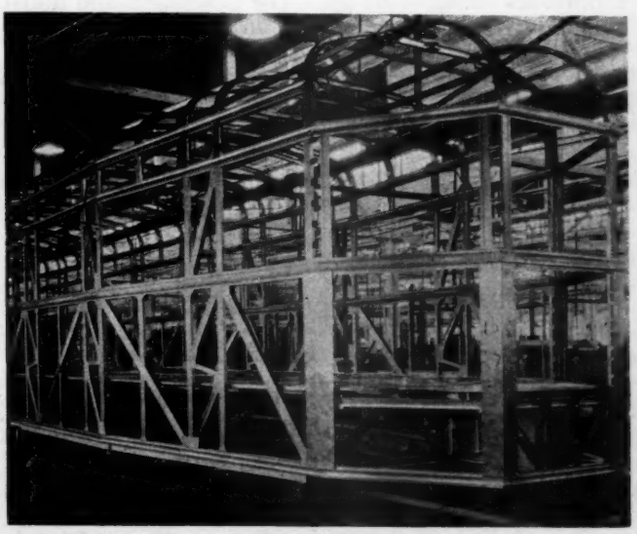
Interior of the white passenger compartment showing the body and roof construction

Condensation from all three sources is conveyed to a hot well from which it is drawn to feed the boiler. A steam train line is provided to carry steam back to the water tanks on the passenger car, to prevent freezing.

The Power Plant

The power plant consists of two 240-hp. American-LaFrance V-12 gasoline engines, each directly connected to a Westinghouse main and auxiliary generator. Each engine and generator, with the two motors on one truck, forms an independent unit. The cooling system consists of radiators, one placed behind louvres on each side of the car. A direct-driven fan draws air through the radiator into the hood with which each engine is completely enclosed and passes it out, part through the roof and part through the floor. The air, thus circulated about the engine inside its own hood, carries out vapors and heat, thus providing clean air in the engineroom and freedom from some of the customary heat.

An unusual feature of the engineroom is the construction of the head end of the car in the form of two large doors which, when swung open, permit the engine and generator units to be removed and replaced. Each engine and generator are mounted as a unit on a cradle which provides a three-point suspension for the engine.



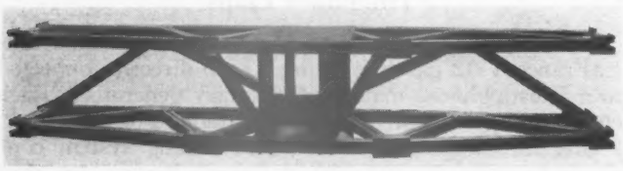
Frame construction at the rear end of the passenger coach

The cradle itself is rubber mounted on longitudinal rails built into the car structure which also serve as collision members.

The motor trucks are of the equalized type with special Commonwealth cast-steel frames and were built by the Baldwin Locomotive Works. Each truck is fitted with two Westinghouse high-speed motors which are completely spring suspended and drive through longitudinal shafts and spiral bevel gears. The wheels are 30 in. in diameter and are mounted on 5-in. by 9-in. axles in the case of the front truck and 4¼-in. by 8-in. axles in the case of the rear truck. All journals are fitted with Timken roller bearings.

Electrical Equipment

The main and auxiliary generators operate in conjunction with a 320-amp. hr. Exide Ironclad storage battery. The battery is used to crank the engines and for lighting and auxiliaries. It does not operate the 7½-hp. motor used to drive the compressor in the air-conditioning unit. To avoid this function and thus reduce the size and weight of the battery required, a simple method of engine control is used. When the air-conditioning unit is not operating the engines idle at 600 r. p. m. and charge the battery. If the air-conditioning motor starts when the engines are idling, the controller is moved over automatically to the first

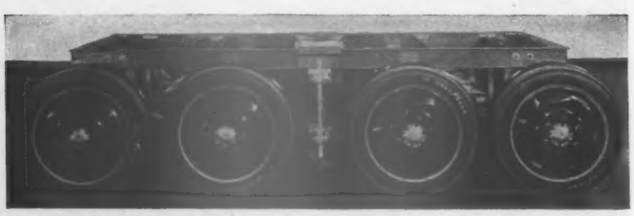


End framing of the permanently coupled ends before assembly into the car structure

notch. This increases the engine speed to about 750 and supplies power for the operation of the air-conditioning unit without taking current from the battery. At operating speeds the battery is charged from the auxiliary generator.

The traction motors are designed for a maximum speed of 5,000 r.p.m. and run at 3,700 r.p.m. at 60 m. p. h. Because of their high speed and special design features, which include the use of aluminum where possible, it has been possible to reduce the weight of a motor to 915 lb. They are self-ventilated and have a continuous rating of 85 hp. The generators also utilize aluminum construction and are rated at 125 kw. Torque control is used.

An engine temperature in excess of 200 deg. causes a red light to light, there being four lights, one for each half of a cylinder block. Failure of the lubricating-



The passenger-coach truck complete

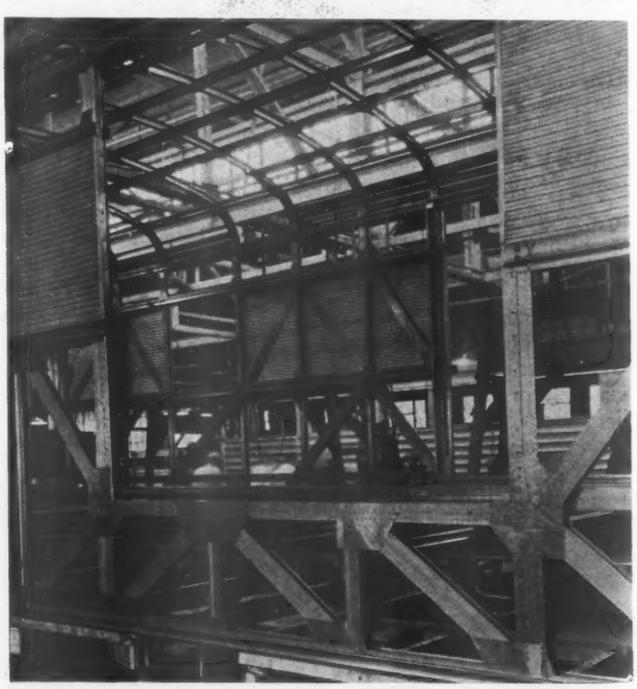
oil pressure shuts down the engine and extinguishes green lights on the panel in front of the operator, after which the engine may again be started at the discretion of the operator. An emergency stop caused by the operation of the deadman's handle, or the conductor's valve, shuts down the engine and opens all contactors.

The lighting in the passenger car is of the indirect type developed by the Budd Manufacturing Company in which the units are placed in the sides of the air duct which extends longitudinally along the ceiling of the car. The indirect lighting is supplemented by a few direct units mounted in the bottom of the duct to augment the lighting in the aisle. The light is well distributed and has an intensity of about 3 foot-candles.

The Rubber-Tired Trucks

The passenger car is carried on 16 rubber-tired wheels in two eight-wheel trucks. The truck frames are of light-weight stainless-steel construction and are provided with deep pedestals within which the Timken roller-bearing axles are guided. Between each and the top of the frame over the pedestal is a relatively long and flexible coil spring. The two end axles in each truck do the guiding. The two inside axles and their pedestal guides are free to move laterally. The Budd pressed-steel demountable wheels are fitted with Micheline safety deflation rings of aluminum. The Goodyear pneumatic rail-car tires are 35-in. by 5-in. and carry a pressure of 100 lb. per sq. in. Each of these tires carries a maximum load of about 2,100 lb.

The power car is equipped with brakes of the Westinghouse S. M. E. system, operating clasp brakes on all eight wheels from truck-mounted cylinders. The same controls operate Bendix-Westinghouse brakes of the automotive type on the passenger car. The four outside



Side frame at the baggage-car door

wheels on each truck are fitted with centrifugally cast-steel drums for the internally expanding brake shoes.

On its trip from Philadelphia to Texarkana, where it will be delivered to the home road, the train has attracted wide attention wherever an opportunity for public inspection has been offered. During the trip the train has maintained speeds up to 75 m. p. h. with ease, the trip from Philadelphia to Chicago being made without need of adjustments of any kind. The cost of operation as compared with a steam train with capacity for the same service, weighing approximately 600,000 lb. including the locomotive, is anticipated to be less than one half the cost per mile of the steam service.

Teamwork with the Supply Department*

Stores department officer comments on how mechanical department can help reduce inventories and insure more effective service

IN casting about for a stores department officer to interview on constructive suggestions for greater co-operation from the mechanical department, I was attracted to this particular officer for several reasons. His road had made an excellent record in reducing and holding down its inventories of materials and supplies, and yet without undue criticism from the other departments because of delays in furnishing materials; indeed, there seems to be almost an entire absence of such criticism. Then too, this officer—like many other stores department representatives—got his early experience in the mechanical department and fully understands its needs and its peculiar problems; incidentally, he makes it a practice, so far as possible, to take frequent trips into the field to keep in touch with actual practical operation.

When we sat down I did not immediately explain the purpose of my visit. We discussed conditions—past and present—as indicated by a variety of performance charts on his desk. Finally he gave me a good opportunity for an opening, when he exclaimed, "The job of the stores department is to provide material *when it is needed and where it is needed*. We must be judged on our ability to meet these requirements."

Intelligent Teamwork a Necessity

"But," said I, "you cannot do this without a lot of co-operation from the material-using departments."

"Just a moment," he interrupted, "I don't like your word 'co-operation'. It has been badly overworked and may mean little or much. It is certainly indefinite. Our success depends largely on the extent to which we can secure intelligent teamwork from the material users. But in the last analysis, it still remains true that it is up to our department to insure that the material is supplied *when* and *where* needed."

"How can the mechanical department work with you more effectively?" I asked.

"We have excellent teamwork now," he replied. "The superintendent of motive power is keen on cutting out waste of labor and material, and keeping down costs. Overstocking means added interest costs, increased handling costs, deterioration of materials, and danger of obsolescence. The management is keenly appreciative of the large amount of money that has been turned back into the treasury during the depression by the more intelligent use of materials, which has made possible a heavy reduction in inventories. This could only have been done successfully by teamwork between the material users and the stores department."

Advance Tips to Stores Department

"Sometimes, however," he continued, "we could get a much better break if the mechanical department officers and foremen would tip off our stores department representatives when they have certain plans in contemplation, which are reasonably sure of being made effective. They do not deliberately keep such information from us, but they quite thoughtlessly overlook the importance of giving us early tips. Sometimes, in fact, we do not know of such plans until they are completed and then we are not infrequently asked to provide the materials on short notice. Had we known what was in the air we could at least have made tentative plans and have been all set to go when the final decision was made. Hurried and rushed service is usually more costly, and, if it can be avoided, relieves the stores department of a needless handicap."

"What else can the mechanical department do to assist you?"

"There are still some material hoarders," replied S. D. O. "We are cutting down the number by attempting to give such a high grade of service that it will make them look foolish. Storing away surplus material in out-of-the-way places means excessive investment and large opportunities for loss, deterioration and obsolescence." And then he cited several instances where hoarders had been converted into teamworkers by such excellent service in material delivery as to discourage the storing up of surplus materials for a "rainy day."

"There is still another way in which we can profit by more thoughtful and intelligent teamwork," continued S.D.O. "The number of items we must carry on our stock list is staggering. Part of our success in reducing inventories is due to progress which has been made in cutting down the number of these items. For instance, we carried an unusually large number of sheet steel sizes in the attempt to reduce the amount of waste in the fabrication of various detail parts. A critical survey indicated that the number of sizes could be greatly decreased by working out various combinations of parts from a single sheet, and this, usually, with little or no greater waste in the fabrication. Such increases in the waste of material as could not be avoided, however, were many times offset by the reduction in inventory, including such items as interest on the investment, increased costs of handling, and deterioration. The same principle can be applied throughout the mechanical department. Of course, the stores department representatives have a large responsibility in such a program of simplification, but the mechanical department can render invaluable assistance.

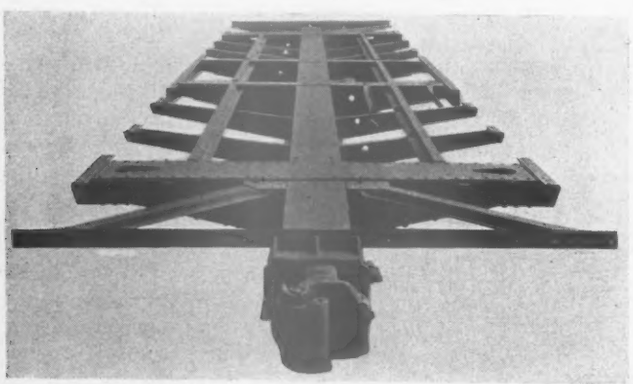
"Please understand," said S. D. O. in closing, "I am not criticising the mechanical department. Our responsibility, as I have already clearly indicated, is to see that that department has the materials *when* they are needed and *where* they are needed. Emergencies will arise and exact conditions cannot always be anticipated. Our success therefore depends upon intimate association with the material-using departments. To that extent our storekeepers must, in effect, practically be members of these departments, in so far as planning for the supplying of the materials is concerned. We can only succeed to the highest degree by the most intelligent teamwork with the material users."

* The fourth of a series of interviews with officers of other departments, commenting in a constructive way upon the possibilities of the mechanical department.

First Standard Steel-Sheathed Box Cars Go into Service

Three of the five cars recently completed by the Pressed Steel Car Company for the A. R. A. are in general service. Two are being subjected to a series of tests to develop exact information as to stress distribution for the use of the Car Construction Committee in its program of periodical revision and improvement

EARLY this year an order was placed with the American Railway Car Institute by the American Railway Association for five 50-ton steel-sheathed wood-lined box cars to the designs adopted as standard by the Mechanical Division following their presentation at the 1932 annual meeting. These cars were built by the Pressed Steel Car Company and, following their completion, were formally inspected by the Car Construction Committee of Mechanical Division, on September 19 at the McKees Rocks (Pa.) plant of the builders. In addition to the members of the Car Construction Committee, those present at the official inspection included representatives of the Federal Co-ordinator of Transportation, Interstate Commerce Commission, Bureau of Safety, the members of the Committee on Car Construction of the American Railway Car Institute which cooperated fully with the Car Construction Committee of the Mechanical Division in the development of the design, as well as other representatives of the builders, specialty manufacturers and railroads.

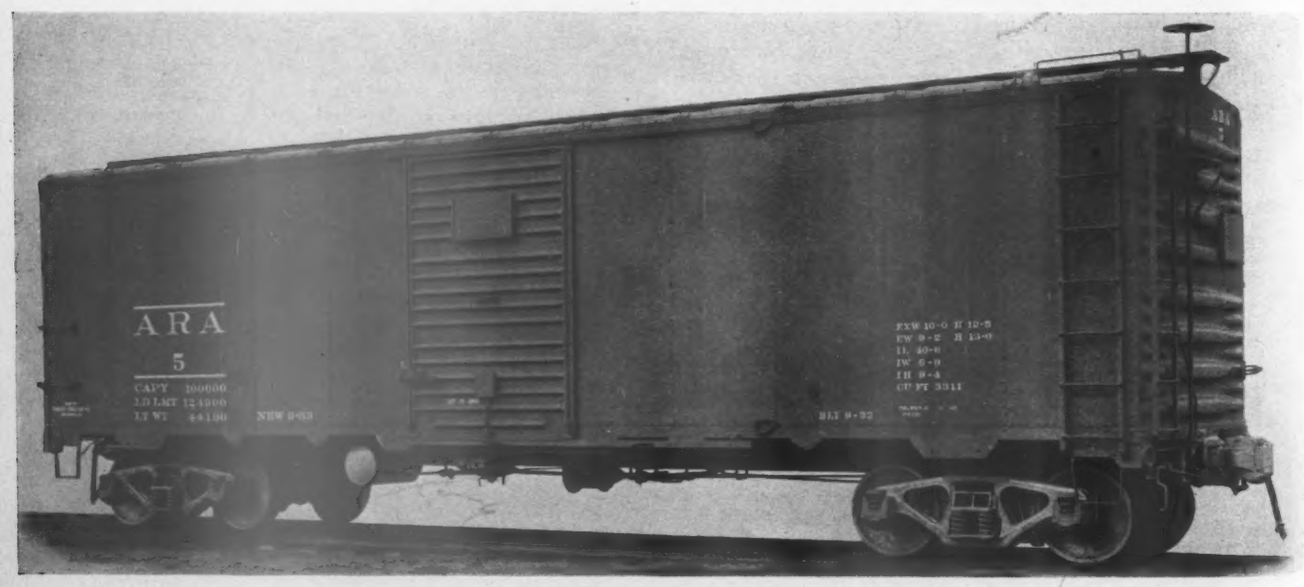


The underframe, showing the intermediate floor stringers

The five cars are all built in accordance with the base design, equipped with the latest designs of proprietary doors, ends and roofs as shown in the drawings included with the Car Construction Committee's 1932 report. The principal difference lies in the fact that three types of door fixtures are used. These are the Camel No. 50 fixtures, the Creco ball-bearing fixtures, both of which are in extensive use, and the Camel lift-type fixtures not yet extensively used.

One of the outstanding features of the new A. R. A. standard cars is the inside height. This has been fixed at 9 ft. 4 in., which has been found to be the maximum height for general, unrestricted interchange service. This is 9 in. higher than the proposed standard design submitted to the Mechanical Division in 1923, but never adopted, and provides an increase of 266 cu. ft. to the volume capacity. The other inside dimensions are 40 ft. 6 in. long by 8 ft. 9⅛ in. wide, and they weigh 44,100 lb. The trucks have Double-Truss side frames and the cars are equipped with AB brakes.

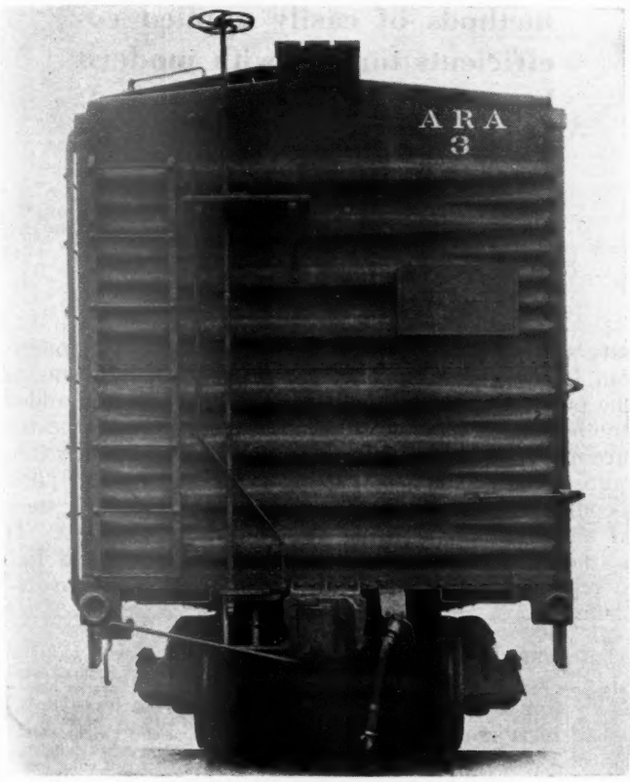
There are several outstanding improvements in the



The new standard A. R. A. steel-sheathed wood-lined box car

construction of the car. These include a lowered center sill, materially reducing the eccentricity of buffing stresses; the single-unit center-sill section of great lateral stiffness, and the attachment of posts to side sills.

One of the illustrations shows the center sill which is formed by welding the inwardly projecting flanges of two Z-bars to form an inverted U-section of greater uniformity of strength than is produced by channel sills closed at the top with a riveted cover plate. The photograph of the underframe shows the intermediate

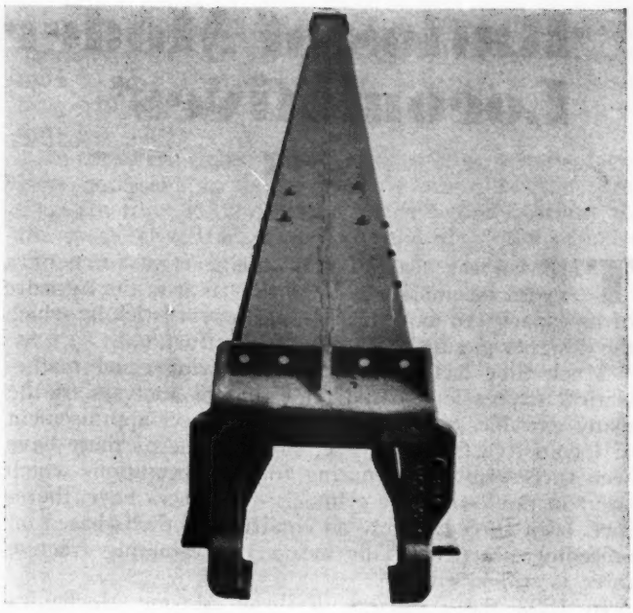


An end view

floor stringers which are also one of the features of the new design.

The side-post attachments to the vertical leg of the angle side sills in the new cars provide for greater strength and rigidity than has been possible in designs in which the posts are attached to the top of channel sills. It will also be recalled that both the posts and the outside sheets are attached to the sills above the floor line, the sill itself forming the bottom closing member so that these joints are removed from the zone of corrosion at the ends of the floor boards.

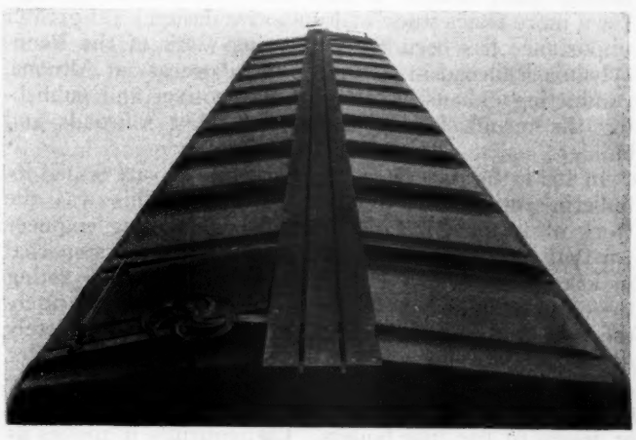
Following the acceptance of the cars by the American Railway Association arrangements have been made for releasing three of them to the railroads for general service. Two were sent to the plant of the Pullman Company where they are being subjected to a program



The center sill

of deflectometer, extensometer and impact tests. Following the completion of the tests these cars will also be placed in regular service.

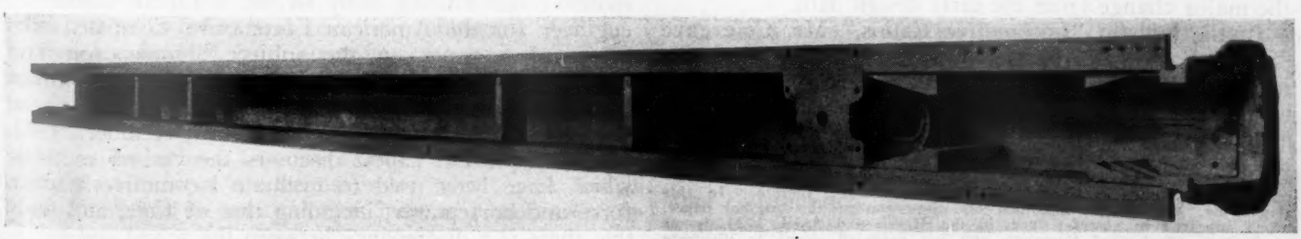
It will be recalled that the principles of the program adopted by the Car Construction Committee, with the



The flexible roof may be used in place of the rigid steel roof shown

approval of the General Committee of the Mechanical Division, on which it proceeded in the development of the design of this car, called for the review of the design each year and for revisions as often as they may be necessary or desirable so as to keep the standard design up to date and representative of the latest state of the art. Unlike the earlier standard designs which

(*Concluded on page 397*)



A bottom view of the center sill

Ratios of Modern Locomotives*

Part I

By H. S. Vincent†

Comments on the revised methods of easily applied coefficients for use with modern locomotives proposed by A. I. Lipetz. A discussion of specific applications and comparisons with methods which are now being used

THE correct evaluation of the tractive force of a steam locomotive is important as it is the measure of its capacity to move traffic, and the yardstick by which the designer gages the success of his effort.

Much time has been spent in evolving exact mathematical expressions based on elaborate analyses of the many variables which enter into a correct appraisement of locomotive tractive force, so far, none of these have been successful in accounting for the aberrations which occur in the locomotive cylinder. Designers have, therefore, been forced to rely on empirical methods based on preceding practice. This means of evaluating tractive force is still in effect.

In 1897 the American Railway Master Mechanics Association adopted a committee report fixing definite design ratios for steam locomotives, based on cylinder volume. These ratios largely governed locomotive design for the next 15 years.

The work of Dr. Goss at Purdue University, and the elaborate tests of locomotives, conducted during the St. Louis exposition in 1904, on the first real locomotive testing plant erected in this country, formed the basis for a more exact study of locomotive design. Of greater importance has been the pioneering work of the Pennsylvania Railroad in setting up its laboratory at Altoona, conducting exhaustive tests of locomotives and publishing the results for the benefit of other railroads and builders.

In 1914, the American Locomotive Company issued its bulletin entitled "Locomotive Ratios." This was the work of Francis J. Cole, late, chief consulting engineer for that company. The issue of this bulletin was epochal in locomotive design as it introduced the idea of rating the output of a locomotive boiler by evaluating separately the evaporation of its component parts. It completely displaced the older method of proportioning the boiler on the basis of cylinder volume. The flexibility of the Cole method, permits its adaptation to radical changes in design of fire tube boilers. Consequently it applies as well today as when first promulgated.

Except for the introduction of the superheater and the normal increase in size and capacity, there has been less change in locomotive boiler design in the past 30 years than one might have expected. This is indicated by the design ratios shown in Table I. It is surprising to note the constancy of the ratio between heating surface and grate area, especially for locomotives with two-wheel trailing trucks, when one considers that at the time of the adoption of this ratio, there were no trailing trucks. The advent of the four-wheel trailing truck has caused the major change from the early design data.

In the bulletin "Locomotive Ratios," Mr. Cole gave "Speed Factor and Horsepower Curves" for determining locomotive tractive force and horsepower as related to piston speed. The curve indicating the ratios for saturated steam, is identical with that used by the American Locomotive Company, for many years previous to the publication of the bulletin. Mr. Cole simply added another curve applying to locomotives using superheated steam. At the period when these superheated steam ratios were promulgated, there were comparatively few locomotives equipped with superheaters and these were of an early design giving relatively low superheat. It is, therefore, not surprising that the curve should fail to represent conditions which came about later, involving changes in superheaters, valve gears and cylinder design.

Table I—Design Ratios

	Ratio of evaporative heating surface to grate area	Ratio of grate area in sq. ft. to volume of two cylinders in cubic feet	Ratio of evaporative heating surface in sq. ft. to volume of two cylinders in cubic feet
Ratios adopted by American Railway Master Mechanics Association in 1897, for bituminous coal.	603	3	200
35 representative locomotive designs built 1914-1919 inclusive. All with two-wheel trailing trucks. 7—4–8–2 8—4–6–2 1—4–4–2 10—2–10–2 9—2–8–2.....	58.7	3.56	207
39 representative locomotive designs built 1928-1932 inclusive. All with trailing trucks. 14—4–8–4 4—4–6–4 3—2–8–2 7—4–8–2 4—2–8–4 1—4–6–2 5—2–10–4 1—2–10–2	55.8	4.26	238
Of the 39 locomotive designs built 1928-32, 27 with four-wheel trailing trucks.	54.2	4.54	247.5
12 other designs with two-wheel trailing trucks.	59.7	3.65	217.5

The most recent contribution to the subject of locomotive tractive force, is by Dr. A. I. Lipetz, consulting engineer for the American Locomotive Company, who presented a paper on the subject "Horsepower and Tractive Effort of Steam Locomotives, (Locomotive Ratios)," before the Annual Meeting of the American Society of Mechanical Engineers in December, 1932. In this paper Dr. Lipetz discusses the various methods which have been used to evaluate locomotive tractive force and horsepower, including that of Cole, and finds that there is a discrepancy between the actual and calculated tractive force as determined by these ratios. Dr.

* An abstract of the discussion of A. I. Lipetz' paper before the American Society of Mechanical Engineers. The author's closure published in the October issue of *Railway Mechanical Engineer* omitted Mr. Vincent's discussion and the author's remarks relating thereto. In this article Mr. Vincent has amplified his discussion of the original paper, which appeared in abstract form in the March and April, 1933, issues of *Railway Mechanical Engineer*, and has prepared charts to illustrate many of his points. This article will appear in two parts.

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Lipetz then proposes a new set of ratios or moduli based in part on the evaporation as determined from the Cole boiler constants, and in part on the steam rate at various speeds, developed in road tests of several modern locomotives. The proposed moduli are related to crank speed, rather than piston speed as has been the usual practice.

It will be recognized that the proposal of Dr. Lipetz is the same in principle as that used for many years by locomotive builders but substitutes a new set of ratios

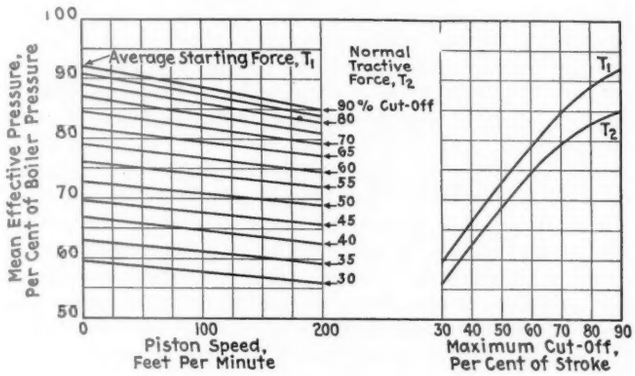


Fig. 1

assumed to express more suitably the tractive force and power of the present-day locomotive.

The Lipetz modulus M^t for tractive force is assumed to be constant for any given r.p.m. or piston speed, regardless of the maximum cut-off for which the locomotive is designed. Included among the six locomotives which are used by him as a basis for his steam consumption curve is one built with a maximum cut-off of 60 per cent, the others having relatively long, maximum cut-off. It is surprising to note from his Fig. 6[1], that even at relatively low speed, the steam rate of the limited cut-off locomotive is shown greater than that of several of the long cut-off locomotives. This is so contrary to the results obtained in tests of a limited cut-off locomotive by the Pennsylvania and which can be easily demonstrated by analysis, that one is inclined to question the validity of that particular test. The answer may be found in the statement of Dr. Lipetz, that the tests which he used as a basis for his deductions, covered a limited range of speeds. It was therefore necessary for him to extend this range by a method which he explains in his paper.

From the writer's experience, there are but few road tests that can be used for establishing normal tractive force or horsepower constants, for the reason that the results obtained are average results, that is, the horsepower, the water and fuel consumption, the speed, etc., are given as the average over a run, and unless one has access to the dynamometer record, or the test is made under constant conditions of speed and grade, the results are unsuited for establishing a rating curve. Road tests are, of course, invaluable to a railroad for giving information which can be used by the transportation department in fixing and adjusting tonnage.

Results obtained from operation of a locomotive on a test plant, such as that at Altoona, when intelligently analysed, give in the opinion of the writer, far more useful information for the construction of rating curves, than can be secured from road tests. In test plant operation, the uniform conditions under which each test is conducted, can be continued as long as is necessary, to secure the desired result. This is impossible in a road test. The apparatus for recording the data, can be operated more efficiently and accurately than is possible on a moving locomotive or car. The test is conducted by a staff, each of whom is thoroughly familiar with his duty.

In considering the subject of locomotive tractive force, it is necessary to define what is meant by the term. Tractive force is the product of the engine constant and the mean effective pressure developed in the cylinder. It is, of course, applied through suitable mechanism to the rail at the rim of the driving wheels but no allowance is made for frictional effects in transmission. There are at least three kinds of tractive force, viz. *Maximum tractive force,* or the effort delivered at any speed, without reference to the efficiency of boiler or cylinder and re-

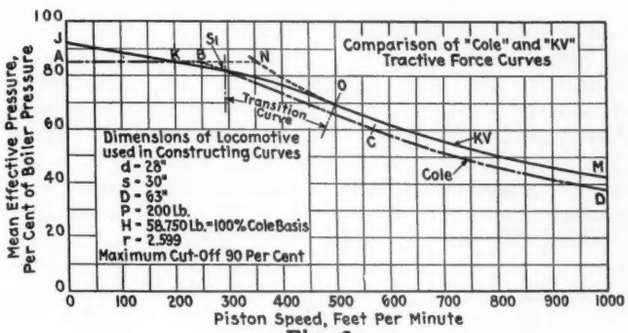

Mean Effective Pressure, Per Cent of Boiler Pressure
Comparison of "Cole" and "KV" Tractive Force Curves
Transition Curve
Dimensions of Locomotive used in Constructing Curves
d - 28"
s - 30"
D - 63"
P - 200 Lb.
H - 58,750 Lb.=100% Cole Basis
r - 2.599
Maximum Cut-Off 90 Per Cent
Cole
KV
Piston Speed, Feet Per Minute

Fig. 2

quiring a steam supply beyond the capacity of the boiler. This is *always greater* than the normal tractive effort. *Operating tractive force,* or the effort which a locomotive delivers in pulling a train, the tonnage of which has been fixed by the physical condition of the road and the necessities of transportation. This is *often less* than the normal tractive force. It is sometimes called performance tractive force. *Normal tractive force,* or the force

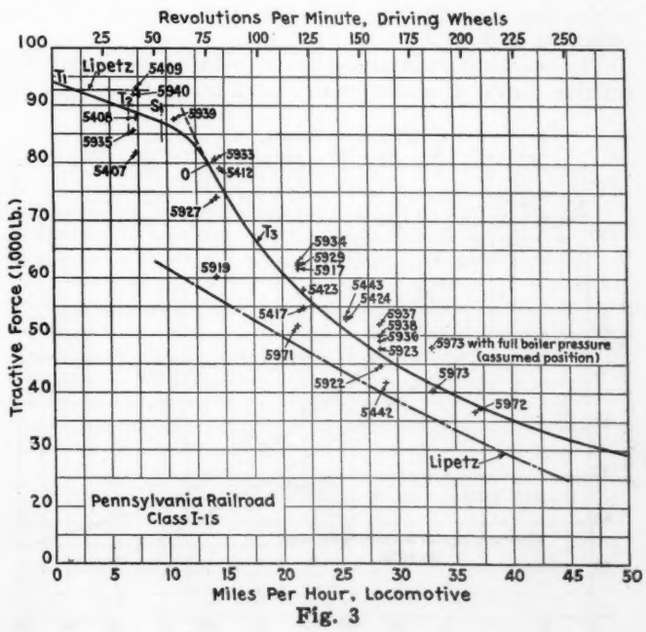


Fig. 3

delivered throughout the total range of linear speed of a locomotive designed and operated in accordance with the best known practice for its type and in which the fuel consumption and evaporation reaches but does not exceed a predetermined limit.

In addition, there is the *rated tractive force,* which

[1] See page 89, March, 1933, *Railway Mechanical Engineer.*

is the measure by which the locomotive is usually compared with others of its type.

In establishing the rated tractive force of a locomotive, it is the custom to select some point on the speed-effort curve, calling this the nominal or rated effort of the locomotive. At this rating speed, the locomotive is assumed to develop in the cylinders a mean effective pressure of aP. From this is developed the well known tractive force formula

$$T = \frac{d^2 s a P}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

in which

T = nominal or rated tractive force, lb.
d = diameter of cylinder, in.
s = stroke of cylinder, in.
P = boiler pressure, lb. per sq. in.
D = diameter of driving wheel, in.
a = a factor depending upon the maximum cut-off.

The value of a, for various maximum cut-offs is given in Fig. 1, and Table II. The broken lines in Fig. 2, indicate by A-B-C-D a graph based on the speed factors shown in Table 14 of the "Locomotive Handbook" American Locomotive Company, 1917, p. 24, generally

Table II—M. E. P. in Relation to Cut-off

Maximum cut-off per cent of piston stroke.	Mean effective pressure in cylinder, per cent of boiler pressure.	
	Average at start or zero speed.	At piston speed of 200 ft. per minute.
90	0.920	0.850
85	0.907	0.840
80	0.890	0.827
75	0.870	0.810
70	0.845	0.792
65	0.818	0.772
60	0.790	0.745
55	0.760	0.720
50	0.727	0.690
45	0.696	0.657
40	0.668	0.625
35	0.630	0.592
30	0.595	0.560

known as the Cole factors for superheated steam. It is characteristic of these tables that a graph constructed from them, consists of a horizontal straight line A-B, a slanting straight line B-C and a hyperbola C-D, as indicated in Fig. 2.

The writer's experience has convinced him that the tractive force of a locomotive at low speed, cannot be

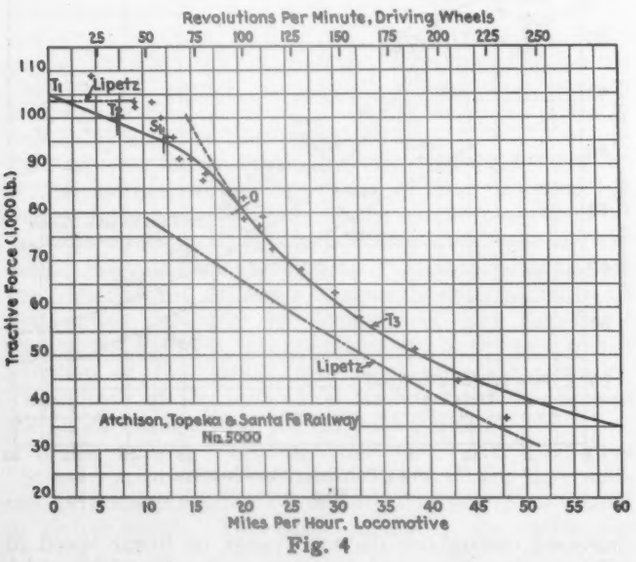

Revolutions Per Minute, Driving Wheels
25 50 75 100 125 150 175 200 225 250
110 100 90 80 70 60 50 40 30 20
Tractive Force (1,000 Lb.)
T1
Lipetz
T2
S
0
T3
Lipetz
Atchison, Topeka & Santa Fe Railway
No. 5000
0 5 10 15 20 25 30 35 40 45 50 55 60
Miles Per Hour, Locomotive

Fig. 4

indicated by a horizontal line such as A-B. It can be shown more accurately by the slanting line J-K, in which K represents the nominal or rated force and J, the average force at starting or zero speed. Many road tests which have been observed by the writer as well as the test records such as indicated in Figs. 3 and 4 would seem to substantiate this contention. Those who have ridden the foot-board of a freight locomotive, know very well that a heavy train can be urged over the "sticking point" at a speed of 2 m.p.h. or less, when 8 or 10 m.p.h. would be impossible.

The vertical position and slope of the line J-K, depend entirely upon the maximum cut-off for which the locomotive is designed. It is evident that as the maximum cut-off is reduced the nominal or rated force for any given engine constant, must be represented by a lower percentage of the boiler pressure. For instance, as indicated in Fig. 1, a locomotive having a maximum cut-off of 90 per cent, has a rated force based on 0.85P, wherease one having a maximum cut-off of 60 per cent, will be rated at 0.745P.

The position and slope of the line J-K, for maximum cut-off varying from 30 to 90 per cent, is given in Fig. 1. These data have been used successfully by the writer for several years, in representing the tractive force of modern locomotives. One very important result of adopting the slanting line J-K, rather than the horizontal line A-B, in representing tractive force at low speed, and of making K the rating point, is that it establishes a norm by which all locomotives of a given type may be measured and compared. The adoption of the horizontal line A-B, permits any locomotive builder who might desire to do so, to claim a higher rated force for a loco-

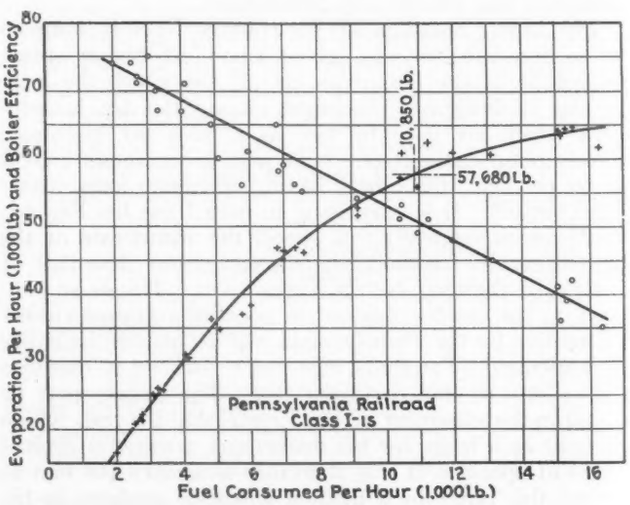

Evaporation Per Hour (1,000 Lb.) and Boiler Efficiency
80 70 60 50 40 30 20
+10,850 Lb.
57,680 Lb.
Pennsylvania Railroad
Class I-1s
0 2 4 6 8 10 12 14 16
Fuel Consumed Per Hour (1,000 Lb.)

Fig. 5

motive than is justified by its dimensions, if a test shows that its tractive force comes at any point on the line A-B, although it is evident, that of two competing locomotives, that one is more powerful that gives its rating nearer B, than A.

There are six major factors involved in the calculation of the tractive force of a locomotive; these are:

(a) the engine constant
(b) the normal flow of steam to the cylinders, lb. per hr.
(c) the working pressure, lb. per sq. in.
(d) the maximum cut-off
(e) the average steam temperature in the cylinder
(f) the speed of the locomotive.

In the writer's opinion, the most practical formula for combining these elements in one equation to form the basis for a correct speed-effort curve, was devised by W. F. Kiesel, Jr., mechanical engineer of the Pennsylvania. The formula has been successfully used by Mr.

Kiesel for many years, being derived from results obtained on the Altoona test plant, but modified to apply to road conditions. This formula as slightly altered and transposed by the writer; is

$$T_s = \frac{1.95\,P_1 M}{1 + (36.66\,MS)\,/\,(Hv)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which

T_s = indicated tractive force, lb.
P_1 = boiler pressure, less 10 lb.
M = the engine constant = d^2s/D.
S = linear speed of locomotive, m.p.h.
H = the normal steam production of the boiler available for the cylinders, in lb. steam per hour, as determined by the Cole boiler constants.
v = specific volume of steam at P_1 pressure and 100 deg. superheat.

For absolute accuracy M, in formula (2) and d, in formula (1), should be reduced in value to allow for piston rod and tail rod (where used), as a rule, this refinement is not considered necessary.

Table III—Test Data on P. R. R. Class I1s Locomotive

1	2	3	4	5	6	7	8
					Mean effective pressure		
Test No.	Rev. per minute	Steam per hour flowing to cylinders lb. = H_1	Actual cut-off per cent of stroke	E	Developed in test	$\frac{1.95\,P_1}{1+E}$	Lipetz modulus $\frac{H_1 M i}{D} / \frac{a^2 s}{D}$
5926	80	30,464	31.6	4.035	98.6	93.0	60.1
5927	80	46,437	50.5	2.650	150.1	128.3	91.8
5933	80	51,918	57.0	2.367	163.1	139.2	102.5
5915	120	34,219	29.6	5.390	79.7	73.3	57.7
5917	120	56,338	49.3	3.275	124.7	109.5	95.0
5929	120	63,650	56.0	2.900	126.2	120.0	107.2
5921	160	37,739	31.0	6.518	68.3	62.3	52.8
5937	160	61,732	49.6	3.982	104.9	94.0	86.3
5938	160	63,192	51.3	3.892	101.0	95.8	88.2
5973	180	60,940	51.6	4.540	81.7	84.6	77.2
5972	200	54,680	39.9	5.625	74.0	70.7	62.6

The complete derivation of the Kiesel formula as published in an article by the late A. J. Wood, in the *Railway Mechanical Engineer*, December, 1916, slightly modified by the writer, is here reproduced. In addition to the notation given elsewhere, let

E = a ratio, found by dividing the total volume of one cylinder, by the volume, which the steam passed through the cylinder in one stroke, would have at the initial pressure.
n = r.p.m. of driving wheels
$m.e.p.$ = mean effective pressure in cylinder

then

$\frac{H}{60}$ = steam per min. lb.

$\frac{H}{60 \times 4 \times n} = \frac{H}{240n}$ = steam per stroke

$\frac{\pi d^2 s}{1728 \times 4 \times v}$ = weight of one cylinder-full of steam

$$E = \frac{\pi d^2 s}{1728 \times 4 \times v} \times \frac{240n}{H}$$

But $n = \frac{1056S}{\pi D}$

therefore $E = \frac{\pi d^2 s \times 240 \times 1056S}{1728 \times 4 \times H \times \pi D \times v} = \frac{d^2 s \times 36.66 \times S}{H \times D \times v}$

but $\frac{d^2 s}{D} = M$

therefore $E = \frac{36.66MS}{Hv}$

$$m.e.p. = \frac{1.95P_1}{1+E} = \frac{1.95P_1}{1 + (36.66MS)\,/\,(Hv)}$$

since $Ts = m.e.p. \frac{d^2 s}{D}$

$$Ts = \frac{1.95P_1 M}{1 + (36.66MS)\,/\,(Hv)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

As that portion of the tractive force curve Ts-0, Fig. 4, is from formulations of the writer and the portion T_s from a modification of the Kiesel formula, the entire curve will hereafter be designated as the KV curve.

It should be clearly noted that the term E, is not the usual expansion ratio, which is the total cylinder volume plus clearance, divided by the volume at cut-off, plus clearance. Except for the addition of the clearance volume, the term E, would be identical with the expansion ratio, if the pressure at cut-off was equal to initial pressure.

It will be observed from the construction of formula (2), that in definite terms, it does not account for clearance volume, exhaust pressure, heat interchange or many other of the quantities usually considered in an exact mathematical expression. These factors are, however, all accounted for in the average mean effective pressure, which is the algebraic sum of all these entities and which is given by the expression $m.e.p. = (1.95\,P_1)/\,(1+E)$.

In Table III data are given from a laboratory test of the Pennsylvania locomotive class I1s, (Bulletin No. 32). In some of the tests, there is considerable discrepancy

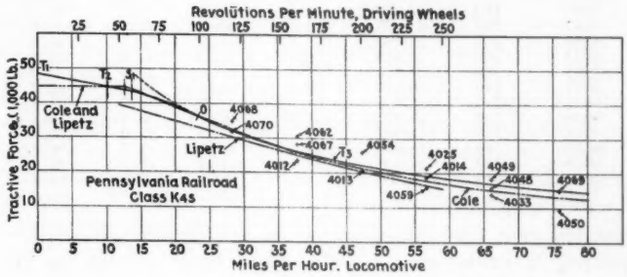

Revolutions Per Minute, Driving Wheels
25 50 75 100 125 150 175 200 225 250
Tractive Force (1,000 Lb.)
50 40 30 20 10
Cole and Lipetz
Lipetz
Pennsylvania Railroad Class K4s
Cole
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Miles Per Hour. Locomotive

Fig. 6

between columns 6 and 7, but much less than that between columns 6 and 8.

For the purpose of showing the applicability of the KV formulas, a number of typical locomotive designs have been selected and their tractive force plotted, Figs. 3, 4, 6, 7 and 8, using this formula. Curves are also shown, based on the Lipetz moduli and the Cole ratios, where the latter are applicable. The locomotive designs selected are those for which the writer has sufficient data to indicate the actual tractive force developed either in a road or laboratory tests covering a considerable range of speed. In these charts the tractive force is related to m.p.h., but in each case r.p.m. is also indicated.

The Pennsylvania class I1s, is represented by Fig. 3. The maximum cut-off of this locomotive is 55 per cent of the stroke. The crosses indicate the tractive force developed on test plant (Bulletin 32). Adjacent to them is the appropriate test number. A few positions are also plotted from an earlier test of a similar locomotive (Bulletin 31). Table IV gives pertinent data corresponding

Table IV—Test Data on P. R. R. Class I1s Locomotive

1	2	3	4	5	6	7	8	9
Test	R.P.M.	Indicated tractive force lb.	Coal as fired		Steam per i.h.p. hr. lb.	Equiv. fuel per sq. ft. of normal grate lb.	Boiler press. lb. per sq. in.	Boiler eff. per cent. incl. superheater
			per sq. ft. of grate per hr. lb.	per hour. lb.				
5933	80	80,600	132	9185	17.3	102.0	247.0	54.0
5412	80	76,900	140	9820	17.3	109.0	246.5	51.8
5927	80	74,200	98	6809	16.8	75.7	247.0	65.0
5919	80	60,350	70	4883	15.9	54.3	248.0	65.0
5917	120	61,600	150	10460	16.4	116.2	247.0	51.0
5423	120	56,400	166	11640	16.6	129.3	251.5	46.6
5417	120	53,400	202	14150	17.9	157.2	248.8	41.6
5971	120	51,600	101	7000	15.6	77.8	247.0	59.0
5424	140	51,400	157	10980	16.1	122.0	249.5	51.7
5923	160	47,700	189	13128	16.7	145.8	247.0	45.0
5922	160	44,600	132	9187	15.4	102.0	249.0	54.0
5442	160	40,750	119	8340	15.9	92.7	248.1	60.7
5973	180	40,350	235	16356	18.0	182.0	211.0	35.0
5972	200	36,560	158	10980	16.0	122.0	243.0	29.0

to the test numbers shown in Fig. 3. This locomotive has a ratio of grate area to the volume of two cylinders, of 2.59, consequently the unit fuel consumption shown

in column 4, Table IV, seems excessive, but reference to column 5, shows that the total hourly fuel consumption is normal. In Fig. 5, the evaporation and boiler efficiency of the Ils locomotive is given, as related to the total fuel consumption per hour. The normal evaporation of this boiler, available for the cylinders is 57,680 lb. steam per hour, as developed from the Cole boiler constants. It will be observed from Fig. 5, that this evaporation is

Table V—Data on P. R. R. Class K4s Passenger Locomotives

1	2	3	4	5	6	7
			Coal as fired			
Test No.	R.p.m.	Indicated tractive force lb.	per sq. ft. of grate per hr. lb.	per hr. lb.	Steam per i.h.p.-hr. lb.	Boiler eff. per cent. incl. superheater
4068	120	34,900	132.6	9180	21.2	57.1
4070	120	31,700	86.6	6000	18.5	67.0
4062	160	30,350	167.5	11580	21.2	50.3
4067	160	28,150	101.9	7060	18.2	65.6
4012	160	23,480	71.3	4940	17.0	69.8
4054	200	25,950	173.3	12000	20.5	49.9
4013	200	20,980	90.9	6300	17.0	62.2
4025	240	21,3 0	139.4	9650	18.7	56.6
4014	240	18,620	92.9	6430	17.4	66.2
4059	240	15,980	68.3	4730	16.2	73.5
4049	280	18,370	145.6	10080	18.4	54.5
4048	280	15,690	83.2	5760	17.0	72.9
4033	280	13,690	63.4	4390	17.0	80.1
4069	320	14,920	126.5	8760	18.3	54.9
4050	320	9,510	49.2	3400	15.4	75.8

reached at a fuel consumption of 10,850 lb. per hr., requiring a grate area on the Cole basis of 90 sq ft. Column 7, Table IV indicates the unit fuel consumption which would have obtained had the grate area been made to conform to the Cole requirements.

The tests which most closely conform to the curve T_s, are 5933, 5412, 5927, 5423, 5424, 5923, 5922 and 5972. The equated fuel consumption for these particular tests, does not, except in one instance, greatly exceed the Cole limit of 120 lb. The boiler efficiencies as shown in column

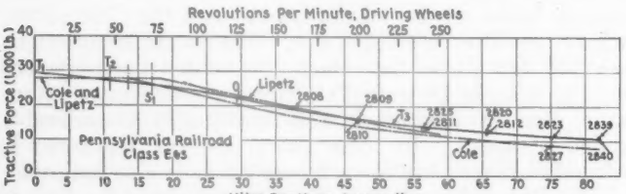


Fig. 7

9, are reasonably good for the existing conditions. Test 5973, which apparently comes near the curve T_s, would actually lie well above it if the boiler pressure were normal instead of being 211 lb. as indicated in column 8.

In Fig. 5, the curves T_1, T_2, T_3, indicate the tractive force of the Pennsylvania passenger locomotive class K_4s, (Bulletin 29) as plotted by the KV method. Curves are also shown based on the Lipetz moduli and the Cole ratios. As in the last example, the small crosses indicate the tractive force actually developed in the tests whose numbers are adjacent the crosses.

It will be observed that for this locomotive the KV and Cole curves are practically identical at speeds from 10 to 40 m.p.h., but diverge at the latter speed. This is to be expected as the K4s, is one of the locomotives on which Mr. Cole based his ratios. The Lipetz curve also approximates the others at medium speeds.

Data from Bulletin 29, is shown in Table V for the test numbers indicated in Fig. 6. The tests which most closely approximate the curve T_s, are, 4070, 4014, and 4069. As indicated in column 4, of Table V, the unit fuel consumption for these tests is well within the range of good practice. The curve T_s, lies about midway between the pairs of tests 4012 and 4067, also the pairs 4048 and 4049. It will be seen from a comparison of the unit fuel consumption for each of these tests, as indicated in column 4, Table V, that the apparent consumption indicated by the position of curve T_s, is not excessive. It must not be inferred from this, that the fuel consumption is necessarily proportional to the position of these test points.

Referring again to Fig. 2, the sloping line J-K, is extended to S_1. At the latter point the straight line becomes tangent to the transition curve which connects the straight portion with the hyperbola. The locus of S_1, is a function of the boiler capacity. Its location may be determined graphically by drawing a horizontal line through K, intersecting the hyperbola at N, S_1 then, equals 0.84 A-N. The position N, is the point on the hyperbola where the cylinders would utilize the normal boiler capacity at maximum cut-off, if the tractive force remained constant from A to N. Stated as an equation;

$$S_1 = \frac{(1.95P_1M) - T_s}{(36.66MT_s) / (0.84Hv)} \qquad (3)$$

The transition curve between the straight portion of the graph J-S_1, and the hyperbola T_s, at O, is empirical.

Table VI—Test Data on P. R. R. Class E6s Locomotives

1	2	3	4	5	6	7
			Coal as fired			
Test No.	Rev. per minute	Indicated tractive effort lb.	per sq. ft. of grate per hour lb.	per hour lb.	Steam per i.h p. hour lb.	Boiler eff. per cent., incl. superheater
2808	160	19,250	98.7	5450	19.5	61.4
2809	200	16,550	126.7	7000	18.8	49.9
2810	200	16,370	129.6	7170	19.0	48.7
2811	240	12,840	82.6	4570	17.1	64.2
2825	240	13,975	128.6	7110	17.9	48.6
2812	280	12,110	98.6	5460	16.8	58.9
2820	280	13,280	108.6	6000	16.9	58.3
2823	320	10,860	126.7	7000	16.4	45.0
2827	320	8,930	98.0	5420	16.7	50.3
2839	360	10,740	144.8	8000	16.3	44.7
2840	360	10,710	117.7	6500	16.0	55.9

An older design of passenger locomotive is represented by the Pennsylvania Class E6s, (Bulletin 21), Fig. 7, indicates the tractive force of this locomotive as developed by the KV method. Curves are also shown constructed in accordance with the Lipetz moduli and

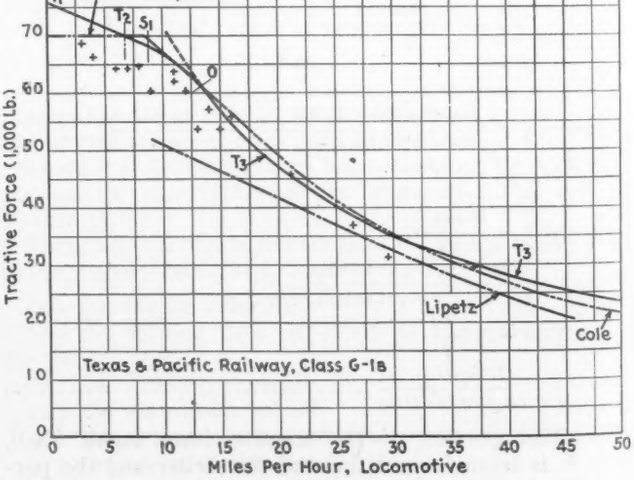


Fig. 8

the Cole ratios. The crosses indicate representative tests, data for which are given in Table VI, Fig. 7, demonstrates that the actual tractive force as developed in tests

2808, 2810, 2825, 2812, 2823 and 2840 is represented very closely by the curve T_3. Reference to column 4, of Table VI, will show that in none of these tests was the unit fuel consumption excessive as rated on the Cole basis. The boiler efficiencies column 7, are normal, considering the very short tubes with which this boiler is equipped (14 ft.). The steam consumption column 6, for the tests in question, show a constantly decreasing range, as would be expected in normal operation.

The three examples cited, represent locomotives of an older design, the date they were initially built ranging from 1910 to 1916. In Fig. 4, is plotted, the tractive force of one of the most modern designs, No. 5000, class 2104, built by the Baldwin Locomotive Works in the latter part of 1930, for the Atchison, Topeka & Santa Fe. Curves T_1, T_2 and T_3, are drawn in conformity to the KV method. A curve is also shown employing the Lipetz moduli. The small crosses indicate the tractive force as developed in a road test, results of which were published in the *Railway Mechanical Engineer*, December, 1931. There is a remarkable correspondence between the curves T_2, T_3 and the test data, at all speeds up to 43 m.p.h. The test at 48 m.p.h lies nearer the Lipetz curve, but at all other speeds, that curve is far from representing the test. At low speed, it will be seen that the test positions lie above the curve T_1 T_2. This locomotive has a maximum cut-off of 60 per cent and is equipped with the Chapman-Lanning starting valves which have very large starting ports, as compared with other limited cut-off locomotives. The effect of these large ports is a virtual increase in the cut-off to approximately 67 per cent, during the time that the ports are open.

(To be concluded)

A Correction

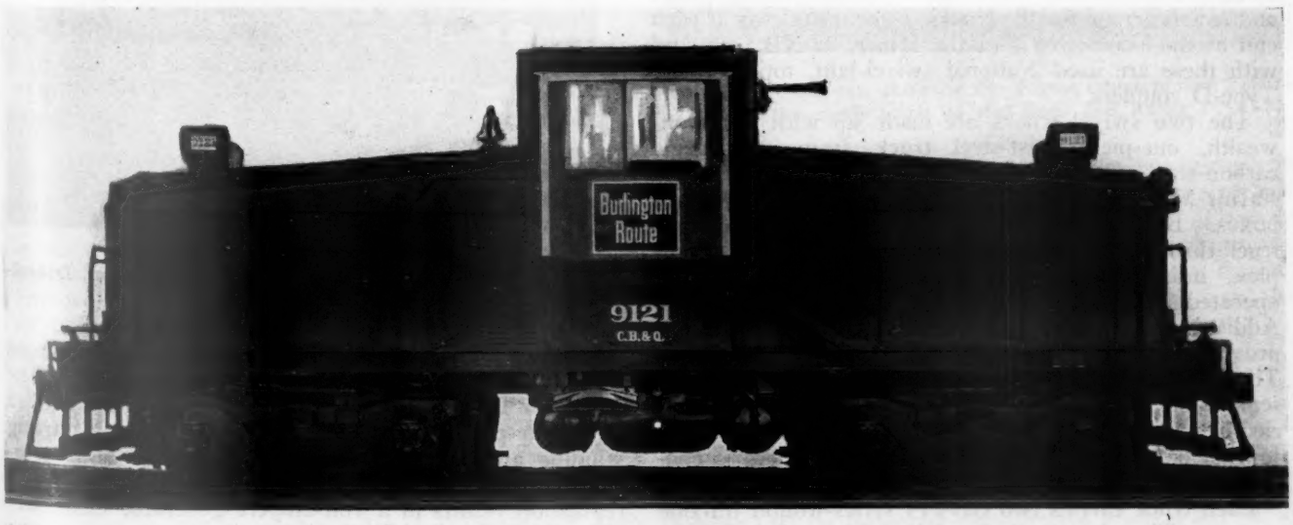
In the abstract of the discussion of A. I. Lipetz' paper on "Horsepower and Tractive Effort of Modern Locomotives" which appeared in the October issue of *Railway Mechanical Engineer* a statement by S. S. Riegel, mechanical engineer, D. L. & W., appearing in the first column of page 361 should read as follows: "We worked out the horsepower and tractive force curves for our most recently acquired fast-freight locomotives by both Mr. Lipetz' simplified and the Cole method, and in our dynamometer tests, when the locomotives were first received, we developed horsepower and tractive force curves in harmony with the results secured by the Lipetz formula. We naturally are satisfied with the deductions as stated in the paper."

Burlington Diesel-Electric Switchers

Driven by Cummins engines, three 65-ton Mid-West machines have rated capacity of 460 hp. each and a maximum tractive force of 40,000 lb.

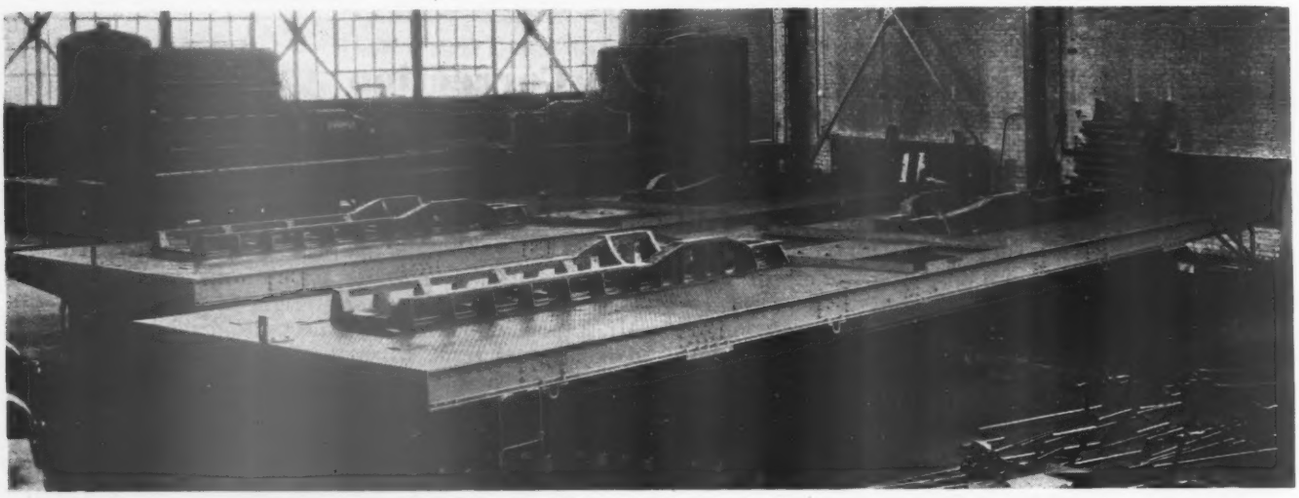
THE Chicago, Burlington & Quincy has just received from the Mid-West Locomotive Works, Hamilton, Ohio, the first of three 65-ton, 460-hp. Diesel-electric switching locomotives, designed for industrial switching or mixed-train branch-line service. The locomotive is designed for sustained operating speeds up to 50 m.p.h. and will develop a maximum tractive force of 40,000 lb. with an hourly rating of 14,600 lb., or a continuous rating of 11,600 lb. Power is provided, for the first time in this type of locomotive, by Cummins light-weight, high-speed Diesel engines, which include a fuel-injection system designed to preheat the fuel before it passes into the combustion chamber and thus assure unusually efficient operation. The locomotive is 41 ft. 4 in. long over the coupler pulling faces, 21 ft. 10 in. between truck centers, 6 ft. 8 in. between wheel centers, 9 ft. 5½ in. wide over-all, 14 ft. 5 in. high over-all, and weighs, ready for service, 132,100 lb.

The power for each locomotive is produced by two



Sixty-five ton Diesel-electric switcher built by the Mid-West Locomotive Works

Cummins Model-KO, 4-cycle Diesel engines, each having six cylinders with 7-in. bore and 9-in. stroke and developing 230 hp. at 1,000 r.p.m. The engines are cooled by means of belt-driven fans and Young sectional core radiators mounted at each end of the locomotive. Each engine is directly connected to a General Electric d.c. electric generator through a flexible coupling. On the opposite end of each generator, a shaft extension fitted with a smaller flexible coupling provides a straight-line drive for a Quincy two-cylinder, 64-ft. capacity air compressor, equipped with Timken roller bearings. These two compressors supply air for brakes, control and operation of accessories and signals. Either compressor has ample capacity to meet the requirements of these different services in case only one of the power-plant engines is operating.



Burlington Diesel-electric switchers in process of construction—View shows fabricated steel frames and steel engine-support castings—Dual power plants installed on frame in background

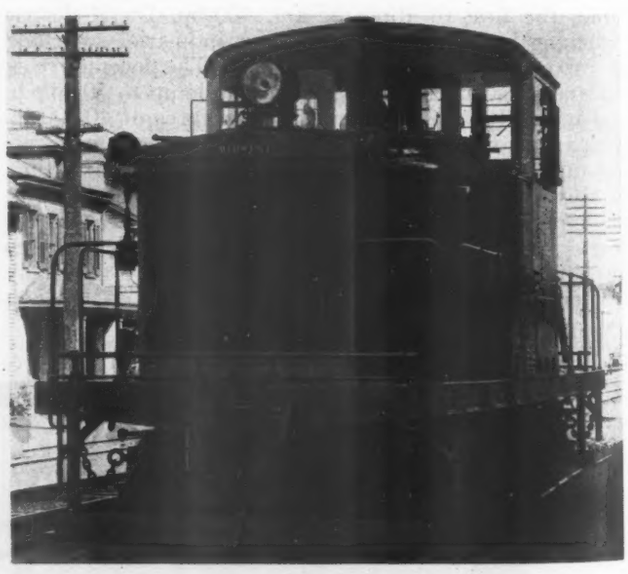
General Arrangement of the Power Plant

Each power plant, consisting of one Diesel engine, one electric generator and one air compressor, is mounted on a cast-steel base of rigid construction, thus minimizing the possibility of distortion or misalinement and failure of connecting couplings. The power plant bases are bolted to heavy fabricated steel frames of riveted and welded construction. These are the main frames forming the backbone of the locomotive and to them are riveted the cast-steel draft-gear housing, center plates and side bearings for the trucks. The draft gear at each end of the locomotive is of the Miner, 22-XB type, and with these are used National swivel-butt, top-operated, Type-D couplers.

The two swivel trucks are made up with Commonwealth, one-piece, cast-steel truck frames, Carnegie carbon-steel axles, Armco 36-in. rolled-steel wheels, and Fafnir-Melcher 5½-in. by 10-in. roller-bearing journal boxes. Brakes are applied to all four wheels of each truck through the use of American Steel Foundries, Simplex, unit-cylinder, clasp brakes, these brakes being operated by two air cylinders mounted on each truck. Additional emergency hand braking on the rear truck is provided by means of a Peacock staffless hand brake. The spring suspension of the trucks consists of two semi-elliptic springs, the ends of these springs being carried between double equalizer bars mounted on top of the journal boxes. Side play on the truck bolsters is controlled by Stucki roller side bearings.

Each truck carries two GE-714 series-wound traction motors. They have axle-bearing linings suitable for a 7-in. axle and a double nose for spring support on the truck bolster. Each motor is ventilated by a multiple fan mounted at the pinion end of the armature and provision is made for forced ventilation if it becomes desirable. The gearing is single reduction with a 65-tooth gear and 14-tooth pinion. All bearings are of the constant-oil-level type with large reservoirs and designed to maintain a constant oil level in the waste chambers as long as there is oil in the reservoirs.

Each electric power generator is of the General Electric GT-1160, four-pole, direct-current, commutating-pole type. The frame is fabricated rolled plate, with supporting brackets welded on the side. The generator has two anti-friction armature bearings and is ventilated by a multiple fan mounted on the armature shaft. The generator is equipped with a self-excited shunt field, a separately-excited teaser field, a series engine-starting winding and a commutating pole winding. The combined effect of the shunt field winding and engine speed regulation results in a volt-ampere generator characteristic which closely follows the engine horsepower curve



Partial front and side view of the Burlington Diesel-electric switcher

through a suitable range and permits full engine utilization over a wide range of locomotive speeds.

How the Electric-Control Features Operate

The control is General Electric Type-P which consists essentially of two master controllers, electro-pneumatically operated contactors and reverser, together with necessary auxiliary magnetic contactors, switches, cables, etc. The control provides for two operating stations, one at each end of the cab. All operations of starting and stopping the engine, regulating the headlights, cablights, etc., and controlling the direction and speed of the locomotive may be performed at either position. The control system is designed so that the two generators operate in parallel, providing a common source of power to which the traction motors are progressively connected in series-parallel, parallel-full-field and parallel-shunt-field combinations. Transfer from one motor combination to the next higher one is effected automatically and occurs at a point which will give the best locomotive performance. This feature, together with transfer contactors and resisters, prevents abuse of the electrical equipment. The operator may, if desired, limit the progression of motor combinations to a definite predetermined point and progression will automatically proceed to that point provided it is permitted by the automatic transfer equipment.

All contactors, switches, relays, etc., are mounted on panels, of which there are two per locomotive. Each panel is arranged so that all connections are made on the front and so designed that it is possible to remove any control item from the front of the panel. Each panel is enclosed in a steel cabinet having two doors, which open into the operator's cab so that the entire panel is accessible.

The cab of the locomotive is of the cupola type and space is provided under the floor for considerable equipment. This space is divided into several compartments, and access to each is had through doors at the sides and trap doors in the floor. In the larger of these spaces are located 32 cells of Exide Iron-Clad MVAH-17 batteries, arranged to provide 64-volt current for the engine-starting winding of the power generators and to supply 32-volt current for the locomotive lighting. In another of these subfloor spaces is located a Curtis two-stage air compressor, driven by a small Briggs-Stratton gasoline engine. This auxiliary compressor pumps air (up to 350 lb. pressure) into two storage tanks, from which the air is piped to each of the cylinders of the Diesel engines. This provides an entirely independent air-starting system controlled with a valve at each operating station. The compressor unit is started by means of a 6-volt starting motor and is equipped with a generator for charging a separate 6-volt battery which supplies the starting-motor current.

Cab Designed for Maximum Convenience and Visibility

The operator's compartment of the locomotive cab is arranged for maximum convenience and visibility. Two operating stations are located at diagonally-opposite corners, both stations being provided with upholstered drop seats and all control levers so arranged that the locomotive may be operated from a standing or sitting position. The control levers and buttons at each operation station consist of engine and generator starting buttons, engine throttle levers, control levers, Emeryville brake valve pedestal connected to Westinghouse No. 6 ET air-brake system, engine starting air valves, auxiliary-compressor-engine starting and stopping buttons, Graham-White sander valve, bell-ringer and horn valves, and switch box for the control of all lights. Each operating station is equipped with power and battery ammeters, fuel, air and lubricating-oil gages for each individual unit.

Operating safety devices include deadman pedal valves which apply the air brakes and cut off the power when pressure is released; an emergency fuel cut-off valve which cuts out the fuel supply to either engine pump; a pressure-operated switch which shuts off the auxiliary compressor engine at 350-lb. pressure; a Sangamo amp.-hr. meter which controls the charge to the storage batteries; Leslie Tyfon air horns; and hinged, clear-vision section windows equipped with Hays automatic air-operated window wipers.

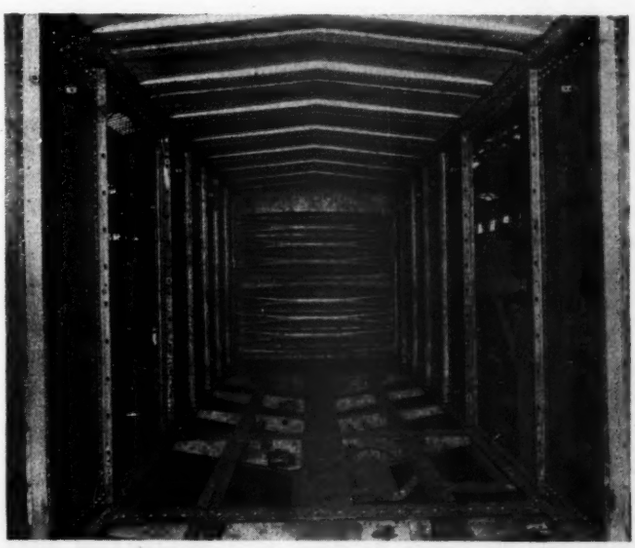
The first locomotive, which has just been delivered, will be broken in at Aurora, Ill., and then placed in industrial switching service at Lincoln, Neb.

First Standard Steel-Sheathed Box Cars Go Into Service

(*Continued from page 389*)

were adopted under a program implying their more or less indefinite continuance as originally adopted, the Car Construction Committee under the new plan will be on the alert for possible improvements and refinements.

It is in keeping with this plan that the program of tests is being carried out. These tests will provide exact



Interior of the car, showing the frame construction before the application of the floor and lining

information for the future use of the committees in improving the distribution of metal in the interests of a still lighter and better freight-car design. They do not imply that there is anything of an experimental character in the present designs. These are a distinct step forward from any that have previously been developed for cars of this type.

THE LONDON MIDLAND AND SCOTTISH OF GREAT BRITAIN will have more than 5,000 containers in service when it receives delivery of 390 which were recently ordered. Of the new containers, 50 will be for furniture traffic, 40 for shipments of bicycles, 200 for high-grade manufactured products and 100 of the open-top type.

EDITORIALS

Rough Handling Of Trains

"I believe if we could get all locomotive engineers to keep the contents of the cars uppermost in their minds and handle trains so as to avoid damage to contents, the cars will take care of themselves." This statement is taken from a letter of a traveling engineer commenting on the interview with the General Manager which was published in the October number of the *Railway Mechanical Engineer*. Is it not a sad commentary on railroad operation to have such a statement made and to realize that in many cases it is only too true?

Railroad engineers have always been regarded as the aristocrats of labor. The recent report to President Roosevelt of the emergency board appointed to investigate the proposed Kansas City Southern wage plan for enginemen and trainmen, clearly shows how the brotherhoods have protected the interests of their members—or rather, have believed that they were protecting them—by punitive rules which "prevent the most economical and efficient operation of the railroad and proper service to its patrons."

Has this attitude on the part of the brotherhoods tended to break down that fine pride in craftsmanship which dominated the old-time locomotive engineer and inspired him to turn out a high grade, finished job? Why does not the engineer think of the comfort of the passenger and the protection to the lading in freight cars while he is operating his train? What is more important for him to think about? Have the managements failed in emphasizing the importance of these things in their educational work? Is this entirely a responsibility of management? What are the leaders of the men doing through their brotherhood organizations? Do not they also have some responsibility in this matter?

If a shipper is forced to go to unreasonable lengths in packaging his products for shipment by rail; if his shipments even then are frequently damaged, why should he not turn to other types of transportation for relief? Since the railroad workers' jobs depend on successfully meeting the competition of other types of carriers, why should they not take a keen and intelligent interest in providing acceptable service? Is it necessary to make double checks on the work of well paid craftsmen, who for purposes of self-interest, if nothing else, should strive to develop the highest standards of workmanship and performance?

The latter question is suggested because of the following statement made in a letter from a road foreman of engines: "Our experience with the handling of freight equipment is that with the long trains little damage occurs, because we have placed shock recording gages in the cabooses of a number of the long trains; the engineer does not know whether or not such a device is operating on his train, and the results shown in connection with handling are good."

It is becoming more or less generally recognized that changing conditions in the transportation field will demand radical changes in railroad equipment, facilities and methods. It seems not unlikely that the approach to the problem of educating and training train service employees may also have to be altered to meet these new conditions. Quite possibly it may mean an entire change of emphasis as compared to common practices now observed on many railroads. That railroad managements have some appreciation of this is indicated by the interviews which were published in our September and October numbers, one with a General Superintendent and the other with a General Manager.

New Life At the Top

More than half of the steam locomotives on the railroads of the United States were over 20 years of age at the end of 1932. Less than one-fifth of the locomotives were under 10 years of age. These facts are striking evidence of the steady accumulation of obsolescence which has been taking place during most of the period since the railroads were returned to private operation by the terms of the Transportation Act of 1920.

During the first five years of this period—from 1920 to 1924, inclusive—7,000 new locomotives were purchased from the builders. During the same years, however, total installations aggregated about 10,700, and it is evident that approximately 3,700 locomotives of the 10,300 retired were reinstated in the inventory after rebuilding and more or less modernizing.

During the next eight years—from 1925 to 1932, inclusive—locomotive purchases amounted to less than 4,500, or an average of about 540 per year. Again, installations exceeded purchases, the total reported being about 9,400, or 1,170 per year.

It was during this period that extensive programs of retirements were undertaken in which large numbers of locomotives were not only retired from the books, but were also actually scrapped. During this eight-year period over 21,400 locomotives were retired, an average of about 2,680 per year. An annual average of more than 2,000 of these locomotives have actually been completely removed from the inventory to be replaced with but 540 new locomotives. The net result has been a decline from a total of about 65,300 locomotives owned at the end of 1924 to 53,300 at the end of 1932.

It is of interest to note that the retirement of locomotives has continued substantially uninterrupted during the depression. Thus, there has been some improvement in the locomotive inventory by removing obsolescence at the bottom during the years when the recession in business has made extensive purchases of new motive power difficult to finance even though justified in many cases by the operating economies which modern power has demonstrated its ability to effect under light traffic conditions. This improvement, however, is entirely negative in character and throughout these years old age has been steadily creeping up on the inventory until the conditions set forth in the beginning of this discussion have been reached. It is evident that the encroachment of obsolescence on the locomotive inventory cannot be arrested by removal at the bottom unless there is an infusion of new life at the top.

During the past three and one half to four years of depression a volume of deferred locomotive maintenance has accumulated sufficient to occupy maintenance forces

and shop facilities for at least 10 months at the rate of operations prevailing during the month of July. Since the July operations were not sufficient to keep abreast of current requirements, it is evident that it would be necessary to much more than double the man-hours employed during July to take care of current maintenance and catch up on deferred maintenance fast enough to get it completely out of the way within 10 months or a year. Every mechanical department officer and supervisor knows what a temporary expansion of operations of this order means. Expanded forces will be inefficient and the need for surplus employment will begin to decline by the time the organizations show signs of shaking down to an efficient basis.

But no small part of the deferred maintenance is undoubtedly represented by locomotives which are being set aside for retirements. The removal of these locomotives from the inventory will thus reduce the demand for deferred maintenance expenditures and effect a further negative improvement in its status.

Few railroads, however, can afford to stop at this point. Unless the retirement program is enlarged enough so that replacements are necessary in order that sufficient aggregate capacity be maintained, old age will continue its steady advance upward toward the top and opportunities for improved service, reduced train-operating costs and further savings in reduced deferred maintenance will be lost.

Generalities do not solve specific problems. No doubt some of the 20-year-old locomotives are not obsolete. Considering the advances in the art which have taken place during the past 10 years, however, there can be no doubt of the fact that, on the whole, the present accumulation of old age is decidedly unhealthy. Each class of locomotives on each railway presents a case which must be decided on its own merits. The present situation in which there is no alternative to an excessive expenditure for maintenance, except the replacement of worn-out locomotives with new and modern units, presents an opportunity for constructive action which no railroad should miss for want of study and analysis.

Equipment Maintenance Costs Can Be Reduced

Since the close of the World War two changes have taken place in the railroad industry which have had a far-reaching influence on the problem of equipment maintenance—first, the progressive increases in railroad traffic which had been common prior to that time changed into a period of marked decline; second, the practice of longer locomotive runs was inaugurated. The first of these two changes marked the beginning of the end of a period of expansion of repair facilities and ushered in a more intensive utilization of facilities. The second of the two changes has led to the consolidation of many shops and engine terminals and is now pointing the way to future economies.

The inauguration of longer locomotive runs proved to operating and mechanical officers that a locomotive was not only capable of rendering far greater service than they had previously considered possible, but also that in order to obtain this service a higher standard of maintenance was required. This has led to many changes in back-shop and enginehouse practice during the past ten years, the most important of which, in the back shop particularly, has been the specialization of work and its segregation into separate departments, the proper functioning of which has been co-ordinated by shop scheduling or production control systems. In doing this the railroad shop, taking a lesson from other industries, set up, through necessity, a means of providing more accurate detailed knowledge of its own operations. Immediately it began to visualize shop capacity not in terms of the output of the shop as a whole, but in terms of the production possibilities of individual departments. The development of the scheduling idea in connection with specialized repairs has produced facts upon which the progress of the last few years has been based. The future is going to demand a still more detailed knowledge of shop operations in order to discover the opportunities for economies.

The trend toward the concentration of repair work at centrally located shops has increased the opportunity for more accurate control of costs. A mechanical officer who a few years back was obliged to co-ordinate the work of many repair points scattered over outlying districts should now be able to concentrate upon the problem of raising the remaining shops and terminals to their maximum efficiency. Opportunities for savings that once represented a small factor in a large problem have now become a larger factor in a smaller problem.

Plans Should Be Based on Facts

Generally speaking, those responsible for the operation of repair shops have considered it sufficient to have accurate information relating to the unit costs of repairs—the average cost of overhauling a locomotive or a car. As far as the operations of the past are concerned, this may have been enough but it is questionable whether or not it will do for the future. It seems possible that only a careful analysis of the individual operations involved in overhauling locomotives and cars will show, by comparison with similar repair jobs on the same types of locomotives or cars, just where the opportunities lie for making improvements in methods or facilities that will assure reductions in costs. The accurate control of costs cannot be accomplished unless the details are known and compiled on a sufficiently accurate basis to permit exact comparisons to be made month by month and job by job. This kind of information provides the supervisor with specific facts that will enable him to determine where the losses are, why they exist and what must be done to stop them. Without such facts no intelligent action can be taken.

Can Repair Costs Be Reduced?

Before attempting to answer the question "Can Repair Costs Be Reduced?" a mechanical officer or supervisor should not overlook the fact that in many railroad shops from 60 to 75 per cent of the machine-tool equipment is from ten to twenty or thirty years old. Consider this in the light of the progress which has been made in machine-tool design in the past ten years, and the added fact that most machine tools built more than ten years ago cannot use the modern tool steels because they do not possess the power and rugged construction necessary to operate at the high speeds and heavy feeds that present-day cutting tools will permit. A glance at the average railroad shop will show many other opportunities for modernizing facilities at substantial savings by taking advantage of the progress in the industrial field.

One of the reasons why industrial plants have made the progress they have is because the modern production engineer is constantly exchanging ideas with men in other plants and spends a substantial part of his time visiting other plants. Unfortunately, this practice is not now common in the railroad field, with the result that we meet many shop supervisors who know all too little about what is going on in their own field. Take, for example, the progress that has been made in the machine shop alone and compare the time required to do any one of 15 or 20 well-known locomotive machine-shop jobs with the time that it is possible to do these same jobs

on machines that have been developed in the last five years. A comparison of some of the savings in machine time on common jobs with the time required on old machines still in service will produce astonishing facts.

The back shop is not the only place where modern facilities offer opportunities for improvement at reduced costs. In spite of the fact that the modern electric crane truck and the electric drop-pit table have become fairly common, it is surprising how many enginehouses still put up front ends and air pumps with manually-operated air hoists and still change wheels, trucks and springs with obsolete home-made drop-pit jacks. Modern equipment would make these operations cheaper and safer and save hours of time that a locomotive might otherwise spend in revenue service. An investigation of the possibilities of the use of the two facilities just mentioned, together with modern boiler washing and direct steaming facilities and modern coal- and ash-handling facilities will show that there are still many engine terminals that could be operated for considerably less expenditure than at present.

Economies in equipment maintenance in the future are going to be made by the more intensive utilization of facilities. Obsolete repair facilities at outlying repair points must be abandoned and repair work centralized at important points where the increased volume of work due to the centralization of heavy repairs will make it economically possible to install only the most modern facilities and methods. It is probable that it will no longer be possible to consider investment in repair facilities upon the assumption that growth in traffic will ultimately produce the revenue to pay for them.

There never was a time when it seemed so desirable for the railroads to consider the advisability of making a thorough study of the entire problem of equipment maintenance. In view of the progress that has been made in industry generally, there can be no question of the opportunities for reducing equipment repair costs, but before an intelligent start can be made facts will have to be developed to show why the present losses exist. The mechanical creations of American industry are already available and ready to serve the railroads in stopping these losses.

More Research For the Railways

One of the popular criticisms of which the railroads have been the target during the depression is their alleged failure to utilize scientific research as an agency by which to improve their physical facilities and methods of operation. For the very reason that it is so unjustified, this criticism has perhaps raised more resentment among railway officers than almost any other to which they have been subjected. That the public might learn the facts the Railroad Division of the American Society of Mechanical Engineers at the 1933 spring meeting at Chicago presented an impressive record of the engineering research projects which have been devoted to many problems of motive power and rolling stock design and operation by the railways themselves, both individually and through the American Railway Association, by universities and by many companies engaged in the development and manufacture of various types of railway facilities. More recently the American Railway Association has issued a volume of some 500 pages in which is developed a brief digest of the research projects conducted by the railways individually and collectively for the improvement of technique in departmental operations, as well as of physical facilities themselves.

Now comes the appointment of a committee by the Science Advisory Board of the National Research Council "to study the matter of scientific research for the railroads in conjunction with the railroad managements and the co-ordinator's organization and, if it thereafter seems expedient, to formulate a plan for carrying on such research to assist in the initiation of the project and to advise in connection with its subsequent development." It may be inferred that the appointment of this committee, at the invitation of Co-ordinator Eastman, is a challenge to criticisms of the railways' lack of research activity on the part of certain responsible scientists.

One of the facts about the railroads which seems extremely difficult for lay observers to comprehend is that, unlike most of the industries popularly associated with the idea of scientific research, the railways are not producers of physical facilities. They produce but one thing for sale and that is transportation service. The materials and equipment which make up the physical plant of the railways are produced by other industries, most of which are engaged in engineering research, each for the improvement of its own product and all for the improvement of railway transportation.

If the railways as an industry are to engage extensively in research for the improvement of their product—which is the purpose of research conducted by manufacturing industries—then the character of the problems which should be undertaken is primarily business and not engineering. Within the realm of engineering problems the most effective research activities of the railways as a whole have been devoted to the determination of requisites where safety, reliability or interchangeability are involved. Further opportunities may be developed whereby the railways may co-ordinate and direct the efforts of industries engaging in the development of new products for railway use. In connection with the business type of research they may also, incidentally, explore the needs of the service for physical facilities not yet available and so stimulate invention and engineering development where most needed.

It may be doubted whether the committee of the Science Advisory Board of the National Research Council will find a large field for special scientific research activities on the part of the railways themselves, unless there is to be a curtailment or duplication of the effort now being put forth by hundreds of other agencies. Let us hope that the committee's findings will at least be the means of effectively enlightening the public mind as to the relation of the railway industry to applied science.

NEW BOOKS

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE. *Published by the Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio. 434 pages, 5¾ in. by 9 in. Bound in semi-flexible leather. Price, $1.50.*

Each of the eight principal sections of this handbook, which is amply illustrated with detailed drawings and photographs, deals with an important phase of arc welding and its application. It has been prepared not only for the use of all welders and heads of welding departments, but also for those responsible for the design of products which may be built by welding. Among the subjects treated in detail are descriptions of various welding processes; definition of welding terms; classification of welds; strength of welded joints; methods for estimating cost of weld production; specifications for steels and alloys of good weldability; treatise on fundamental advantages of arc welded and riveted steel structures; use of arc welding in cement plants, machine shops, railroad shops, etc.

THE READER'S PAGE

Methods of Finishing Babbitted Truck Brasses

To the Editor:

In the car department section of the August, 1933, issue of the *Railway Mechanical Engineer* appeared an article on machining the wearing surface of truck brasses on the shaper using a circular disc, the same size as the journal, for a cutting tool. The use of this method is not confined to small car brasses, but is applicable to engine truck and trailer brasses as well. Some shops use it on brasses up to 7 in. in diameter and claim a great time saving over other methods. A set of these disc tools is provided, varying by thirty-seconds of an inch for all the different sizes of journals used. Those who use this method claim to finish car brasses in three or four minutes each, and 7-in. trailer brasses in about 10 min. after the set-up is made for the first brass.

Is it natural to suppose that the use for a formed cutter like the above would effect a saving of time in machining operations? I should like to see a further discussion of this method. Is this method practical on the largest brasses and where a considerable amount of stock must be removed? Is the time saving great enough to pay a back shop to make up a complete set of disc cutters?

A Reader.

What Is the Best Piston Packing Ring?

To the Editor:

A discussion of locomotive piston packing rings should be of considerable interest to the readers of the *Railway Mechanical Engineer*. It seems to me that there must be one best form of packing ring, but it is certainly difficult to determine just what it is. Some roads are using snap rings ¾ in. wide by ⅞ in. deep, two to each head; others use ⅜-in. wide by 1¼-in. deep snap rings. Some are using sectional rings of various styles. I have also found cases where they are being re-turned on the outside diameter after they have been split. Some shops split the rings on a 45-deg. angle (although I cannot find any good reason for this) and others cut out a rectangular section. There is considerable difference of opinion as to how much to allow for side wear of the grooves before renewing either the piston head or widening the grooves and applying oversize rings. Some shops make no difference in making up rings for stock whether they are to be used in a cylinder of the original size, say 26 in. bore, or whether they are to be used in the same cylinder when it has been bored to its limit of, say, 26½ in. diameter.

There is also some variation as to the amount to allow for the spring of these rings. This variation is found to be from ⅛ in. to ½ in. over the size of the cylinder bore, cutting out sufficient material to close the joints to within 1/16 in. when the rings are in place. There is also a diversity of opinion as to the material to be used in the manufacture of rings.

Piston packing rings are an important part of a locomotive and I should welcome some discussion from other railroad men as to their experience relating to packing ring practice.

Shop Superintendent.

How Should Taper Fits Be Made?

To the Editor:

Many large railroad shops still follow the practice of grinding in taper fits of piston rods and crossheads, as well as many other taper fits on locomotives, with oil and emery. Some shops have a home-made rigging to do this job, utilizing the steam end of an old air pump operated by compressed air, with an arrangement of levers to oscillate the parts being ground. It is my opinion that these fits can be more accurately made in a lathe and that the grinding or lapping operation is a waste of time. Lapping is admitted to be the most accurate way of fitting parts together, particularly two flat surfaces, or such cases as lapping a piston in a cylinder, but the conditions surrounding a taper fit are somewhat different from this. The grades of abrasive and the methods used in railroad shops very often result in the parts being "ringed" due to the cutting action of the abrasive and, when finally finished, are rougher than when they were delivered from the lathe. Many large shops do not lap taper fits. It seems to me that a discussion of the methods followed in fitting tapered parts would be worth while in these columns.

Shop Mechanic.

What Is Your Opinion?

To the Editor:

Rule 30 states that steel underframe wood cars can be weighed after 12 months when built new. The question is can foreign cars when built new be weighed after the 12 months' limit by others than the car owners? I can see nothing in the rules that prohibits any railroad from weighing foreign cars and getting paid for it.

Can foreign cars be sent to repair tracks for air brake cleaning after 14 months, or must the 15-month limit be used if brake is not defective?

A Reader.

A Hobo Pigeon.—Canadian National forces in the yards at Moncton, N. B., are telling proudly about an itinerant pigeon which has temporarily chosen the tender and cab of a C. N. R. switch engine as its favorite roosting place. The pigeon delights to ride the length of the yard on the engine but, oddly enough, chooses to supply its own motive power for the return trip. Despite the fact that a number of switch engines are employed in this yard, the pigeon always picks the same one for its daily trips.

With the Car Foremen and Inspectors

Safety Appliances*

By P. P. Barthelemy

IN designing safety appliances for railway cars, the basic measurements used in determining certain dimensions and clearances were not arrived at in a haphazard manner. In general they are based on measurements of parts of the human body, and located in positions that combine the greatest safety with the highest degree of convenience. We must always bear in mind that sill steps, hand holds, ladders, etc., receive their maximum usage while cars are in motion, which, in switching movements, are frequently accompanied by quite severe shocks. The uniform location within practical limits for all detail parts is such that a man may almost safely reach for any of them with his eyes shut, as he knows within a few inches just where they are located on the car.

Hand hold and ladder tread clearance, minimum two inches is the room necessary to clear a large hand encased in a heavy mitten. The adopted length of the hand holds is to provide ample room for making the catch and, at the same time, to permit sufficient spreading apart of the hands to provide a secure balancing of the body. This also applies to the ladder treads, in which case this length also provides plenty of foot room and clearance.

We have a four-inch clearance on the projecting end of the uncoupling lever handle, that much room being considered necessary to permit a firm grip. The same applies to hand brake wheel clearance.

Ladders are located not over eight inches from the corner of the car, as that is about the maximum distance a short man can safely reach with one foot against the guard of the side ladder tread and the other against the guard of the corresponding end ladder tread, or vice versa. That is also, of course, the reason for the guard legs of the ladder tread being on the end of the tread away from the corner of the car. The use of the so-called safety tread for ladders on cars where the metal ladder is not used is a long stride toward greater ladder safety. By safety ladder tread is meant a tread with a foot guard at both ends, on all treads of the ladder. It eliminates the chance of a man losing his balance due to his foot slipping off the end of the ladder tread.

Sill Steps and End Ladders

The sill step maximum height from the rail of 24 in. is the maximum height a short man may reach safely, track conditions, etc., taken into consideration. Incidentally, don't forget that this measurement is taken with the car having the coupler up to maximum height, as obviously if you applied a sill step 24 in. from the rail to a car of 33½-in. coupler height, you would have a penalty dimension as soon as the car was raised to a 34½-in. coupler height. Coupler height must be taken into consideration when making any adjustment to car body parts based on height from rail.

End ladder clearance of 12 in., 24 in. for two cars coupled, is based on the knee-to-hip room required by a large man ascending or descending the ladder.

Sill step width minimum of 10 in. is the room necessary for safely placing two large feet side by side. The eight-inch vertical clearance is to provide ample room for clearing the toe of a long foot when descending from the step. And right here there is one point to which I wish to direct attention; that is, that on some constructions you may find the necessary eight-inch vertical clearance, at the same time there may be a protruding part back of the step under which the tilted-up toe of a descending man's shoe may get locked, preventing or interfering with the free removal of his foot and possibly causing the man to be thrown. The sill step application should be so made as to avoid such possible hazards, or the danger point properly guarded.

Hand Holds and Ladder Treads

There is another hazard of a similar character in connection with hand hold and ladder tread applications, particularly hand holds, and that is that while the prescribed clearance is for the length of a member between the bends it sometimes happens, particularly in connection with special applications, that one leg of the hand hold may be close to some protruding part, possibly an inch or so, in which event a man's finger or thumb might get caught in the space when the hand is placed on the extreme end of the hand hold, as is often done, and a personal injury may result. In such instances, the hand hold should be placed against the obstruction to close this dangerous gap, or far enough away from it to provide ample clearance.

Running boards are made a minimum of 18 in. wide to provide a safe footway when the car is lurching in train or switching movement. The end of the running board protrudes to within 6 to 10 in. from the knuckle vertical plane, this to provide as narrow a gap as possible between the running boards of coupled cars, and yet to keep them far enough apart to prevent the running boards from bumping each other. Nails are prohibited as running board fastenings, as they tend to loosen and work out. The wood screw is the most commonly used fastening device. Unfortunately, too many car men think a sledge hammer is a screw driver, but its use for that purpose is prohibited. Drive the screws in the manner in which they were made to be driven. Even then you'll have enough trouble with them later when they start working out.

The most desirable fastening for roof running boards is a flat-head bolt secured to metal saddles, and I look forward to the time when the wooden saddle and the accompanying wood screw will be prohibited. While we are on the running board subject, let's take a look at some of the most persistent troubles with this device. The wood saddle split-checks and decays, the wood screws have the thread rusted away and work upward, when they become a menace; running boards crack, due to short grain lumber; but worst of all is decay. The

* Abstract of a paper presented by P. P. Barthelemy, assistant master car builder, Great Northern, before the October meeting of the Northwest Car Men's Association, at St. Paul, Minn.

best way to prolong the life of the running board is to give it a good all-around coat of good car cement or a dip treatment in paint. It is best to use the boards in the rough, as they provide a safer footing, are thicker than if dressed, and at the same time will hold the protective coating better, be it car cement or paint. Another safety measure, and one that helps prolong the life of the running board, is to sprinkle fairly coarse sand into the fresh paint. Only first-class lumber should be used for running boards, being careful to avoid the use of boards in which the grain runs out every few feet, as such boards soon split to pieces, are dangerous, and their use for that purpose is not otherwise economical.

There are innumerable other items connected with safety appliance locations, etc., far too many to cover in a brief paper but open, with those mentioned, for a good lively discussion, with particular emphasis on maintenance.

Paint-Brush Vat

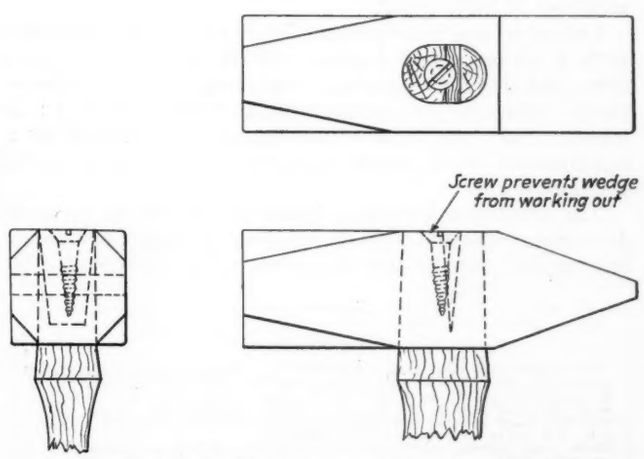
A GENERALLY-satisfactory type of paint-brush vat, developed at the Shawnee (Okla.) shops of the Chicago, Rock Island & Pacific, is shown in the illustration. This vat assists materially in keeping paint brushes in good condition by providing a bath of linseed oil or turpentine for individual brushes, which are always conveniently available, by means of the revolving feature of the design.

Referring to the drawing, the construction of the vat is apparent. It consists of an outside case *A*, made of No. 24 B. W. G. galvanized iron, 24¾ in. in diameter by 23 in. high and provided with a hinged lid to keep out dust and dirt. Equipment inside this case consists of a soldered base structure *B* and vertical center rod on which revolves a multiple holder *C* and eight brush containers *D*. The bottom of holder *C* is slightly tapered to the center where a small collar is provided to bear on a similar collar on the base and permit the holder to revolve with little friction. Three-quarter inch holes are provided in the bottom of the holder, as illustrated, to drain off any small amount of oil which may be spilled. Eight ¼-in. rods equally spaced and soldered in place serve to position the brush containers *D* which are made oil-tight to the dimensions shown and provided with five nails soldered to the sides of each container to support individual brush handles.

In operation, each of these containers is filled to the required level with linseed oil or turpentine, and brushes used with the same color of paint are kept in the same container. The result is that there is no possibility of mixing colors; the brushes are always kept in good condition; and are readily available when needed.

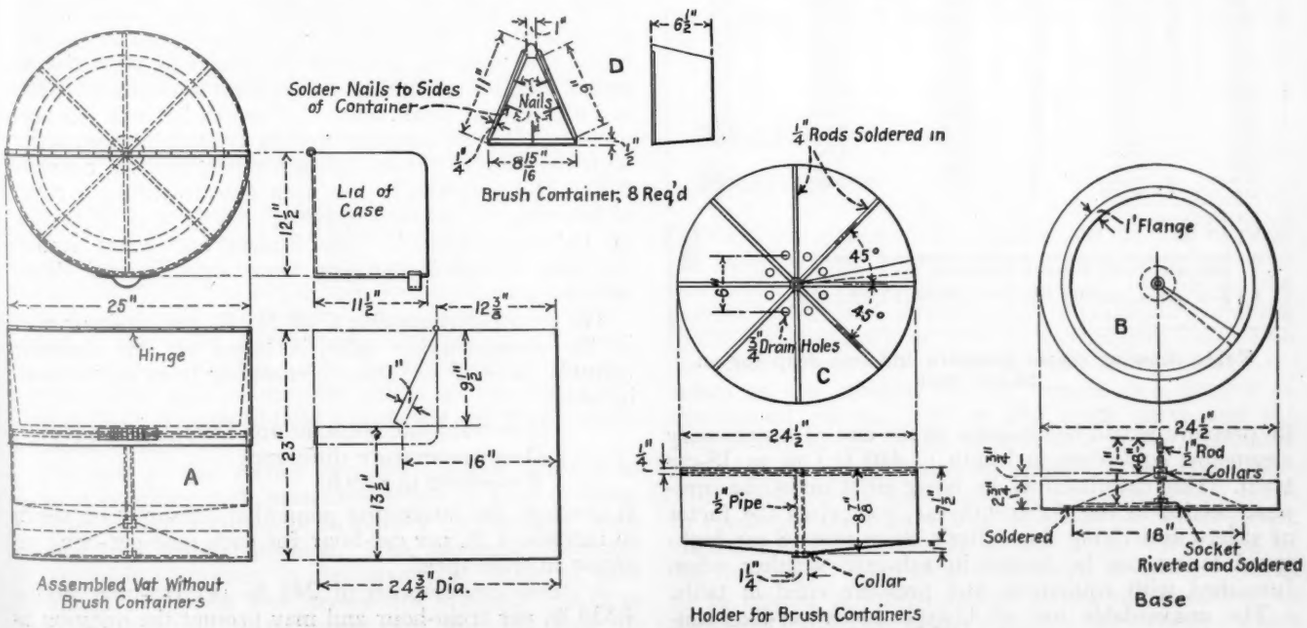
Locking a Hammer Head

A METHOD which may not be particularly new but which has proved eminently satisfactory for securing a hammer head firmly to its wooden handle is shown



Method of locking hammer head on handle

in the illustration. It consists of sawing a slot in the head end of the hammer handle to a depth of the thickness of the head. After placing the handle in the head,



Details of a vat which keeps paint brushes in good condition

a tapered wooden wedge is inserted and driven home as shown. This wedge is, itself, firmly held in place and prevented from backing out by a suitable standard wood screw, applied so that a portion of the screw enters both the wedge and the handle. The size of screw should be in proportion to the size of the hammer and when applied, as indicated, will make a neat job and securely hold the hammer head against working loose on the handle.

Can an 18-Car Passenger Train Be Heated?

By W. J. McClennan

THE application of available formulas has revealed a sufficient factor of "safety" to warrant a conclusion that properly maintained 18-car trains can be properly heated in sub-zero weather when traveling under high windage at high speed.

Owing to the fact that practically all cars are equipped with a steam vapor heating system having 2-in. train lines and 1½-in. radiators employing steam at atmospheric pressure (or at temperature of 212 deg. F.) it is known that long trains can be properly heated if a minimum of 10 lb. steam pressure can be assured on the eighteenth car.

The accompanying table, based on theoretical pressure drop data intended for steam lines of fixed structures, but applied step by step to railway cars, reveals that 81

TRAIN HEATING TABLE

Calculations illustrating, theoretically, the feasibility of adequately heating all the cars of a solid Pullman eighteen (18) car train traveling at 50 m.p.h. through average windage of 37 m.p.h. in temperature zones 3 deg. below zero when carrying 175 lb. steam pressure at locomotive reducer, all such cars being equipped with Vapor steam heating system, 2-in. train lines, 2-in. end valves and 2-in. metallic connectors.
(Note: Steam consumption (C) 241 lb. per car-hour, with conditions and equipment cited)

Position of car in train	A No. cars from rear	B Gage pressure at head end of car stipulated	C Steam wt. (lb.) consumed per min.	D Wt. (lb.) of 1 cu. ft. saturated steam at gage pressure indicated	E Pressure drop in train line of each car (P − p)	F Per cent drop $\frac{E}{B}$
1st	18	175.00	72	.4154	11.510	6.1
2nd	17	163.49	68	.4037	10.600	6.4
3rd	16	152.89	64	.3800	9.980	6.5
4th	15	142.94	60	.3541	9.360	6.5
5th	14	133.58	56	.3380	8.860	6.4
6th	13	125.02	52	.3190	7.830	6.2
7th	12	117.19	48	.3018	7.050	6.0
8th	11	110.14	44	.2871	6.220	5.6
9th	10	103.92	40	.2721	5.430	5.2
10th	9	98.49	36	.2601	4.640	4.7
11th	8	93.75	32	.2488	3.840	4.1
12th	7	89.91	28	.2397	3.020	3.3
13th	6	86.89	24	.2323	2.280	2.5
14th	5	84.61	20	.2266	1.650	1.9
15th	4	82.96	16	.2226	1.060	1.2
16th	3	81.92	12	.2196	.606	0.7
17th	2	81.314	8	.2179	.281	0.3
18th	1	81.033	4	----	----	----

B = Initial B − E
C = $A \times \frac{240}{60}$

D = Mean of weight at initial and final pressure B − Page 32-VI Harding & Willard Heating & Ventilation.

E = $\frac{C^2}{D} \times .0009\dot{2}4$, resolved from : $P = .000132 \left(1 + \frac{2.6}{d}\right) \frac{WL}{wd^5}$

Table showing steam pressure and line drop for an 18-car train

lb. pressure would be available at the end of a stationary steam line equivalent in length (1,440 ft.) to an 18-car train. This calculated 81 lb. being eight times the pressure needed in the eighteenth car, comprises the factor of safety underlying the writer's claim that 18-car high-speed trains can be heated in sub-zero weather when furnished with equipment and pressure cited in table.

The unavoidable use of U-type condenser-like connections between cars, the impossibility of securing either absolutely steam-tight connections at all couplings or effective insulation throughout this 1,400-ft. train line explains why something less than the calculated 81 lb. pressure would actually be available at the rear end of an 18-car train, as no such obstructions to steam flow are met on stationary steam lines in connection with which the formula was developed.

At the average steam flow rate (4,338 lb. per train-hour) and at the average pressure cited in column B, the pressure drop through each of the 36 U-type connectors would be approximately 1¼ lb., or 45 lb. for all those on train. As to shape and diameter, the writer's pressure-drop calculations accord these connectors only the same consideration as the straight steam line through the train. If we now make a further allowance for this 45-lb. drop it can still be said that the gage pressure at the head end of the eighteenth car would be 36 lb. This being 3.6 times the pressure required at the rear car, there results a sufficient margin to support the claim that 18-car high-speed trains can be heated by 175 lb. locomotive pressures in sub-zero weather when heating equipment is properly maintained.

Possible leaks at couplings and the slight pressure drop at non-insulated sections are not sufficiently important to negative the use of a fixed structure formula for railway-train determinations. Then, too, it is felt that no one will urge the point that 130 lb. pressure would heat the train under the severe conditions stated and formula proves it will not, thus establishing its consistency.

Test data have never been available for the conditions cited (18 cars, 175-lb. pressure—241 lb. steam consumption—3 deg. below zero; 37 m.p.h. windage; 50 m.p.h. speed; full 2-in. train line), but to support the calculated conclusion that such trains could be heated, the writer applied certain data from running tests made in February, 1927. These data indicate that the actual steam-pressure drop per car at the fifth Pullman car was 10.1 per cent; tenth car, 8.2 per cent, and fifteenth car, 5.3 per cent. Interpolations from the same tests, reconstructed to an 18-car basis, reveal that the required 10-lb. rear-car pressure would be greatly exceeded. Thus, it can be said that the running tests (allowing for mathematical reconstructions) prove that the eighteenth car of the train under discussion will be supplied with a minimum 10-lb. pressure and that the entire train can, therefore, be heated.

The formula follows admitted assumptions that the pressure drop varies with the initial pressure at the locomotive reducer, pressure at head end of each car, steam weight consumed per minute, length of train and diameter of steam lines. (Unwin's formula has been used for loss of pressure due to friction in connection with the flow of steam through pipes, but the constant 0.000132 for 0.000131 has been substituted as a result of inserting Carpenter's 0.0026 as the value of *K* instead of Babcock's 0.0027. The Unwin and other similar formulas admittedly employ many experimental determinations.)

The steam consumption *C* of 241 lb. per car-hour used in the accompanying table is based on the tentative formula, $B = 45 + 2D + S$, resulting from recent tests, in which:

45 = train-line constant for Pullman cars
D = temperature difference
S = speed in m.p.h.

It develops the interesting point that consumption seems to increase 1 lb. per car-hour for each mile-per-hour increase in train speed.

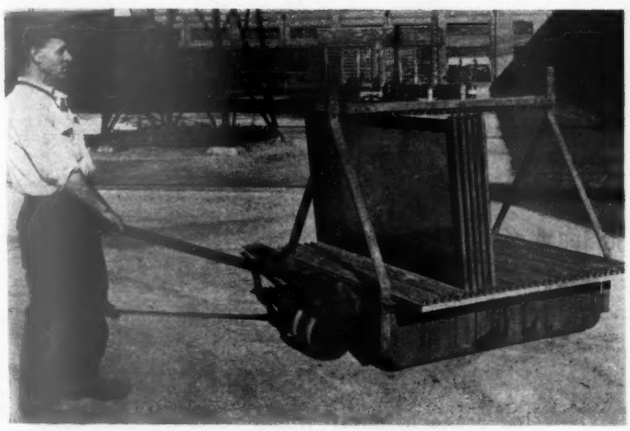
A steam consumption of 241 lb. per car-hour means 4,338 lb. per train-hour and may prompt the question as to the ability of the locomotive to spare this amount for

train heating, but this hourly requirement is only 7.28 per cent of the total capacity of a modern locomotive, as one type considered has an average equivalent evaporation at the superheater header of 59,553 lb. of water per hr. over a 140-mile division with a 26-car train operating at an average speed of 43 m.p.h.

With locomotives equipped with 3-in. pipes from dome to turret and with 2-in. line from turret valve to stop and reducing valves, thence to the rear of the tender, in lieu of the former 1½-in. stop valves just ahead of the reducers, there is no interruption in the full 2-in. line from the locomotive turret to the rear of the train, thus insuring free flow of the indicated steam weight at the 175-lb. steam pressure authorized for train heating under the conditions cited in the accompanying table.

Sash-Rack Skid

THE illustration shows an adjustable sash-rack skid which has been giving unusually good results at a large passenger-car shop in the middle west. The management of this shop has for some time been extending the use of skids wherever possible to avoid manual handling and, in line with this policy, developed the skid illustrated for handling sash. It consists of a standard steel skid, 34 in. wide by 54 in. long by 13 in. high, on top of which is applied a wood platform of 1-in. material laid crosswise. On top of this platform is placed a sheet of corrugated galvanized iron, with the corrugations



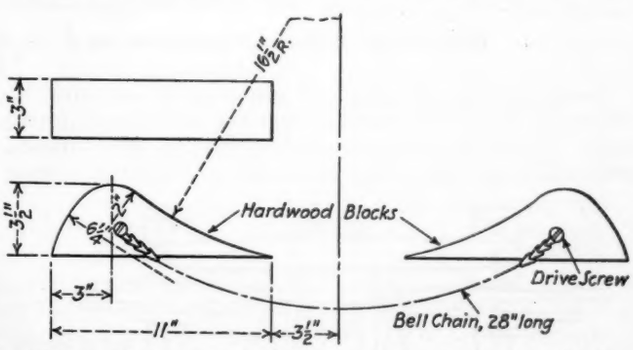
Special skid and lift-truck arrangement which greatly facilitates sash handling in the passenger-car shop

also located crosswise and spaced 1½ in. on centers to take 1-in. sash. Two ⅜-in. by 2-in. mild-steel strips are riveted to each end of the skid and brought together at the top to support an adjustable horizontal bar equipped with similar galvanized iron spacers to hold the upper sides of the sash. This horizontal bar is positioned by means of locking pins, as illustrated, and will accommodate sash of varying widths, as required. The skid is large enough to hold a complete car set of inside or outside sash.

The use of this device prevents possible damage to sash in handling and, moreover, tends to keep it clean, as dust cannot accumulate as readily on the sash when carried in a vertical position. The principal advantage of the skid, however, is the saving of labor in sash handling. At least five moves are normally made in handling sash for heavy repair cars, namely, from the car to the wash rack, wash rack to repair bench, repair bench to paint shop, paint shop to trimming department and trimming department back to the car. As compared to the former practice of unloading sash from a truck and reloading after each operation for movement to the next department, the sash-rack skid, illustrated, saves at least five manual handlings of the sash.

Wheel Blocks for the Repair Track

WHEN one end of a car is jacked up on the repair tracks it is necessary to block the other end of the car so that it will not move. Many methods have been used to do this but the wooden blocks shown in the drawing seem to be particularly simple. The blocks are cut out from scrap lumber at the mill and are held together with "scrap" bell chain. They are not only safe and efficient but contribute to a great extent in



Wheel blocks used when one end of car is raised

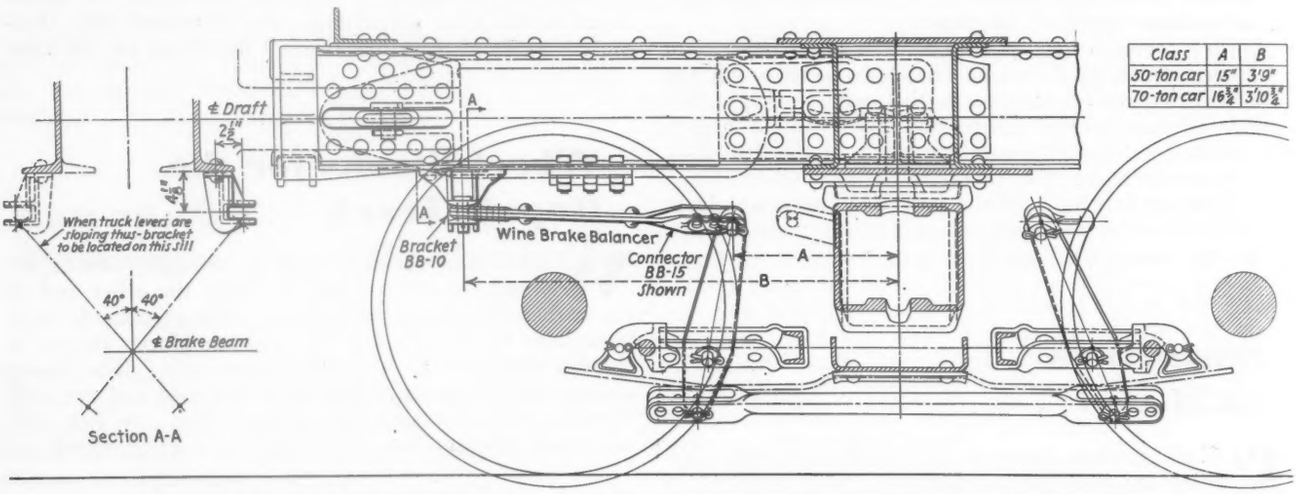
keeping repair tracks clean by avoiding the necessity of having larger blocks, boards or timber around the tracks for this purpose. Many times workmen will take new sheathing, lining or flooring and use it for blocking cars and by so doing damage the new lumber to such an extent that it is unfit for further use.

Two sets of these blocks are given to each gang of two men with the understanding that they are a part of their regular tool equipment and are moved along with the tools from car to car.

Brake Balancer

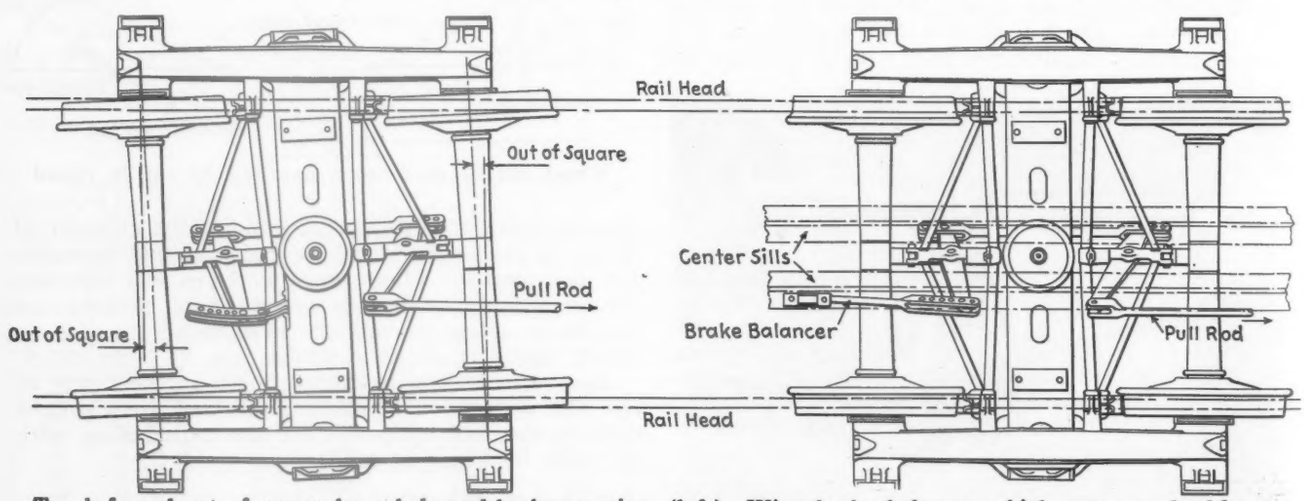
THE foundation brake rigging on by far a great majority of present freight equipment embodies essentially the same general principles utilized in the earliest brakes and introduces an unbalanced condition due to securing the dead lever to an eccentric location on the truck bolster. The introduction of this brake reaction on this movable car part results in a number of detrimental effects, both in the truck parts and the functioning of the brake, as well as creating a potential hazard in the operation of cars under certain conditions. The brake force, applied to an eccentric point, tends to rotate the truck as well as to create an out-of-square condition. This is clearly shown at the left in one of the drawings. Even should the truck be so constructed as to remain perfectly square, its normal resistance to swiveling causes increased flange-to-rail pressure which

may greatly exceed the pressure caused by unbalanced brake action due to the attachment of the dead lever to an eccentric location on the truck bolster. This results in a more or less serious hazard to safe operation. the necessity of connecting the upper end of the dead lever to an eccentric location on the bolster as is customary practice. With the Wine balancer bracket and connectors, the brake reactions are returned to the under-



Wine Brake Balancer Application to A. R. A. Standard 50-Ton and 70-Ton Capacity Cars

Summarizing, the apparent results of the eccentric location of the brake reactions and the unbalanced forces are: (1) Increased wear to wheel flanges, wheel treads, axle collar and associated parts, due to the truck's being frame of the car where they were originated by the cylinder, thereby relieving the truck of all the reactions of the brakes other than the necessary functions of retardation. The construction of the Wine brake balancer



Truck forced out of square by unbalanced brake reaction (left); Wine brake balancer which removes dead-lever fulcrum reaction from the truck bolster to the car center sill (right)

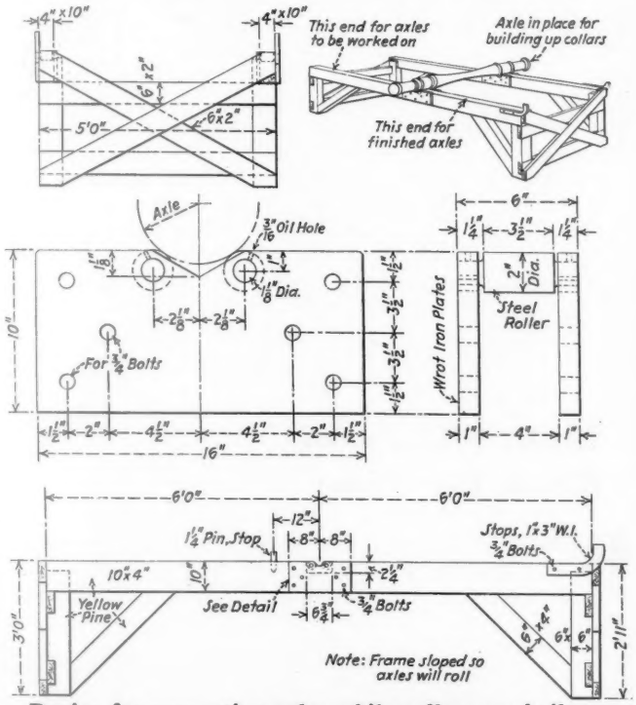
swiveled; (2) undue wear on side frames at the bolster guides and to the bolsters at the guides, on the faces through which the unbalanced brake forces are transmitted; (3) variation in braking forces when the trucks swivel under cars, also transverse loads on brake beams and additional loads on brake hangers for certain positions of the dead lever fulcrum; (4) a tendency to derail when the brakes are applied, particularly under a light car where the brake ratio is maximum and when the flange and rail conditions are conducive to the wheel flanges climbing the rails.

To overcome this condition and to relieve the trucks of this unnecessary wear and unbalanced reaction, the Wine Railway Appliance Company, Toledo, Ohio, has developed the Wine brake balancer which is illustrated. This device comprises essentially a bracket riveted to the underframe and a balancer connector rod which engages the upper end of the dead lever by a three-position pin-and-clevis arrangement. The use of this device avoids is apparent from the drawings and it is said to be applicable to any standard type of freight car, offering no new problems in brake adjustment for shoe wear. The fundamental dimensions of the brake balancer application to the A. R. A. standard 50- and 70-ton capacity cars are indicated in one of the drawings.

No Competition for This Shipment.—Railroad transportation had the field to itself when the time came to transport material for one of the gates to be used to seal the diversion tunnels after the Hoover Dam has been completed. Truck lines eager to take care of the movement were conspicuous by their absence. The reason was that each gate consists of 19 girders weighing 35 tons apiece, 38-ton vertical girders for each side, and a large number of steel plates 1½ in. thick. The rivets used to fasten together the various parts of the gate weigh more than the average yard locomotive. The completed gates weigh 3,000,000 lb. each, are 55 ft. square and 12 ft. thick, and contain more steel than is used in erecting a 12-story office building.

Welding Axle Collars

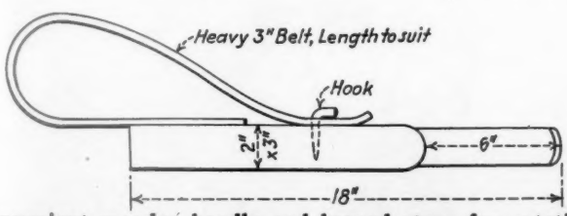
A NUMBER of railroads follow the practice of building up worn car axle collars by welding and, for this operation, the device illustrated has proved helpful. It consists of a rack so constructed that storage space is provided on one end for axles waiting to be worked on and at the other end for axles after the collars



Device for supporting axles while collars are built up by welding

have been built up by welding. In the center, two pair of steel rolls are provided, on which the axle is supported at the wheel seats and can be readily rotated during the welding operation, using the wooden handle with a looped strap shown in a separate illustration.

Referring to the drawing, the construction of the rack will be apparent. It consists of a well-braced wooden



Convenient wooden handle and looped strap for rotating axles

framework, having 6-in. by 6-in. yellow pine corner posts and two 10-in. by 4-in. horizontal members on which the axles roll, the beams being spaced so that the axles roll on the wheel seats. The beams are sloped 1 in. in 12 ft. so that the axles will roll more readily, and suitable 1-in. by 3-in. steel stops are provided at the lower end. At the center of the rack four wrought-iron plates, 16 in. by 10 in. by 1 in. thick, are provided to support four steel rollers 2 in. in diameter by 3½ in. wide, which support the axles during the welding operation. These rollers are arranged to revolve freely in the steel plates, being provided with suitable oil holes for lubrication. Detailed bearing dimensions are shown in the drawing.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Joint Evidence for Bent Tank Head on Private-Line Car

PENNSYLVANIA-CONLEY Tank Car WSRX 537, in lease service of the White Star Refining Company, was delivered by the New York, Chicago & St. Louis to the General American Tank Car Corporation shop at Madison, Ill., with a bent tank head at the A end of the car, requiring renewal. This car was one of 110 cars being sent to the shop for repainting and incidental repairs and carried no defect card or bad-order card on its arrival at Madison shop to identify the road on which the damage occurred. Joint inspection was secured and signed by inspectors of the Nickel Plate and the Pennsylvania-Conley Tank Car Company. The joint-inspection certificate was submitted in due time to the Nickel Plate with a request for a defect card to cover, the Pennsylvania-Conley Tank Car Company contending that in the absence of any damage having occurred elsewhere the delivering line was responsible. The Nickel Plate contended that inasmuch as the car was moving from the owners to a contract shop for repairs, the delivering line was not responsible for any damage that existed. In its statement the Pennsylvania-Conley Tank Car Company said that in the absence of any evidence of damage having occurred elsewhere the Nickel Plate was responsible for damage existing on arrival at the shop, bearing in mind the fact that the car was shopped for painting and not for repairs to a damaged tank head. They further contended that the car owner should not be required to assume responsibility for damage of this nature and that, inasmuch as Rule 4 is for the protection of the car owner in cases of this kind, responsibility should be placed with the delivering line in the absence of any evidence to the contrary. The New York, Chicago & St. Louis in its statement traced the movement of the car over lines prior to the time it was delivered to the Nickel Plate and contended that in Section (k) of Rule 4 the intermediate road was exempt from any defects existing, unless there was conclusive evidence of unfair usage having existed on the intermediate road. It also stated that the car met with no accident while in the possession of the Nickel Plate.

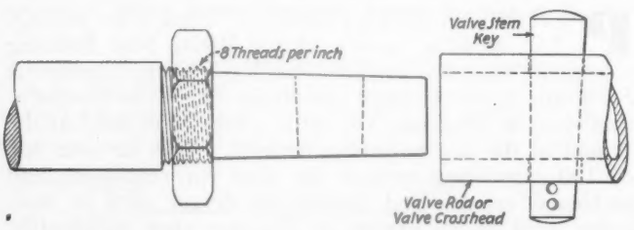
In a decision rendered November 4, 1932, by the Arbitration Committee it was ruled that: "Unless the provisions of Section (k) of Rule 4 were complied with in the movement of the car to the contract shop, defect card is properly due from the New York, Chicago & St. Louis."—*Case No. 1719, Pennsylvania-Conley Tank Car Company vs. New York, Chicago & St. Louis.*

In the Back Shop and Enginehouse

Nut for Pulling Valve Stems

TROUBLE is frequently experienced in pulling valve stems out of the taper fit, especially on some locomotives equipped with Stephenson gear having the valve stem fit in a socket in the end of a long valve rod. The only provision for pulling these stems is a small round hole through the valve rod where a tapered drift pin may be inserted to wedge out the stem. It is sometimes necessary to use a gas torch to loosen the fits.

To overcome this difficulty one road threads the valve stem for 1 in. back of the shoulder and screws an eight-thread nut on the stem. The diameter of the threaded



Turning up the nut loosens the taper fit

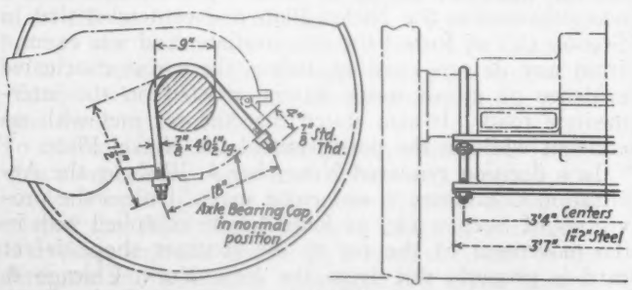
portion is the same as the limit of turning for the valve stem, so that the packing and packing cone and push ring will pass over the threaded portion after the diameter of the stem is reduced to the minimum allowable size by repeated turning. To pull one of these threaded stems it is only necessary to drive out the tapered valve-stem key and then tighten the nut, thus parting the fit. Before this was done it was necessary to use a special valve-stem puller on some locomotives and on others a wedge was used between the combination lever to part the fit.

Removing Booster Axle-Bearing Caps

WITH the increasing number of booster-equipped locomotives, shop and enginehouse forces have been confronted with the problem of developing the easiest and most convenient way of removing trailer wheels when necessary to turn the tires or make other wheel changes. One method of accomplishing this is by means of the special clamp arrangement shown in the illustration.

Before the trailer wheels are removed, the axle-bearing cap is clamped to the axle, using two 1-in. by 2-in. steel bars which are held firmly against the axle-bearing cap by two ⅞-in. U-bolts, extending around the axle. The cap is then unbolted from the booster housing and lowered with the wheels into the drop pit. The wheels are subsequently raised up to the floor, where the bearing cap is removed during the tire-turning operation.

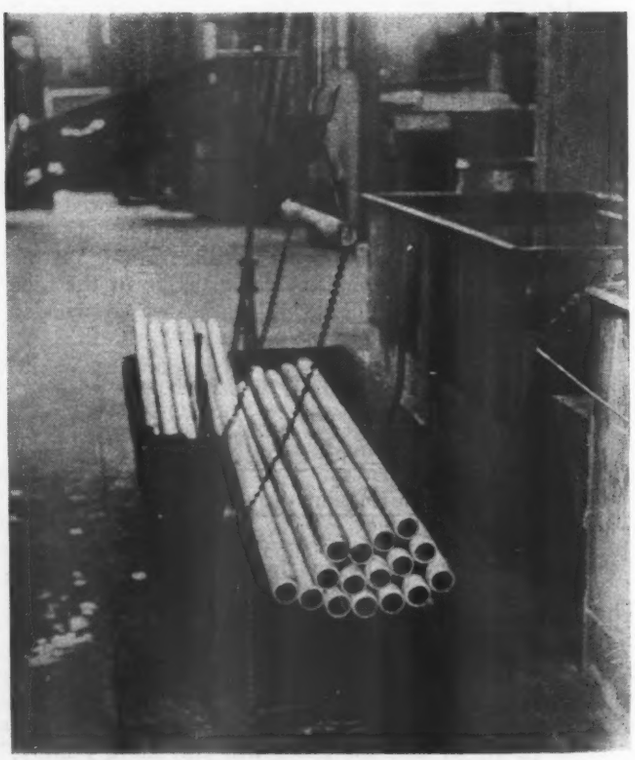
After the wheels have been turned, the axle-bearing cap is again applied to the axle, using the same clamping arrangement. The wheels are lowered into the drop pit and both the wheels and the axle-bearing cap again raised and bolted into position, ready for service.



Device for removing booster axle bearing cap with trailer wheels

Light Sling and Rack for Pipe

BUNDLES of pipe are easily picked up with an overhead hoist when a rack and sling like that shown here is used. The rack is made by welding small



Bundles of pipe are easily picked up with this sling

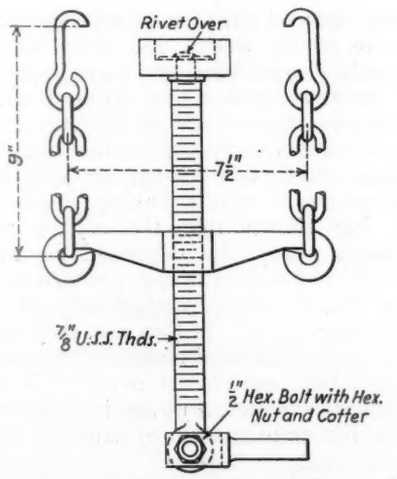
rods together, with the top members curved upward to hold the pipe together about 18 in. off the floor. This gives plenty of room for attaching the two chains of

the sling. These are welded at one end to a section of pipe and have a hook at the other end to fasten them around the material to be lifted. A rod, welded to the sling pipe, with twisted loop hooks on the hoist.

Grease Cellar Puller

A CONVENIENT device for use when refilling driving-box cellars with hard grease cakes is shown in the illustration. It consists essentially of a crossbar forged of open-hearth steel, provided with a chain and hook arrangement on either end to engage the indicator pins, and drilled and tapped at the center to receive a 7/8-in. threaded push rod with a swivel bearing cap at the upper end and a hinged handle at the lower end for turning purposes.

In operation, the end plate of the cellar to be filled is first removed and the two hook chains attached to the

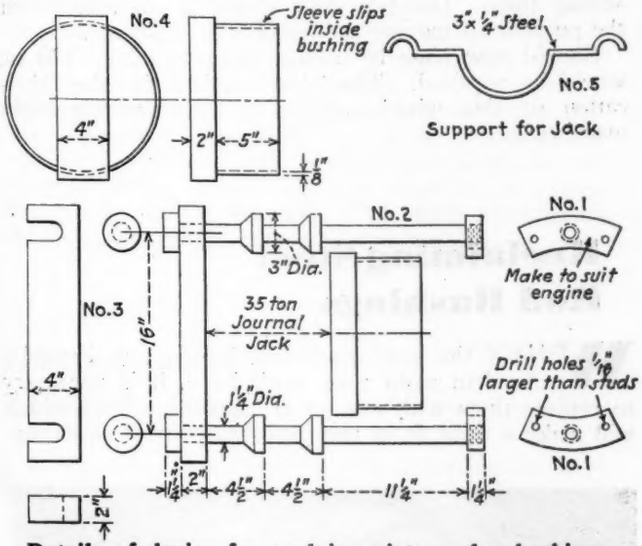


Driving box grease cellar puller used in refilling cellars

indicator pins on the follower plate underneath the driving box. The center push rod is then screwed up until the swivel cap bears against the bottom of the cellar. Continued revolution of the push rod has the effect of pulling the crossbar, chain hooks and indicator pins downward until the follower plate is in its extreme lower position, permitting easy application of a complete or partial cake of new hard grease.

Device for Applying Piston-Valve Bushings

THE drawing accompanying this article shows the details of a device developed by the general foreman of a mid-western locomotive shop for applying piston-valve bushings. The two parts, No. 1, in the drawing are lugs that are fastened onto the studs of the valve chamber head. Special bolts (No. 2), made of 3-in. soft steel turned down to 1¼ in. diameter, are screwed into the tapped holes of part No. 1 at top and bottom, and a bar, part No. 3, with slotted openings is slipped onto the ends of the special bolts so that it rests against the heads of the bolts. Part No. 4 is a combination bar and sleeve bushing made of boiler plate welded to the bar which serves to keep the bar in a central position and also acts as a safety device to keep the bar from dropping out when the pressure of



Details of device for applying piston-valve bushings

the jack is released. Part No. 5 is a support for a 25-ton journal jack which holds the jack at the center while the ends rest on the special bolts which are stepped off 4 in. apart to permit readjustment of the jack.

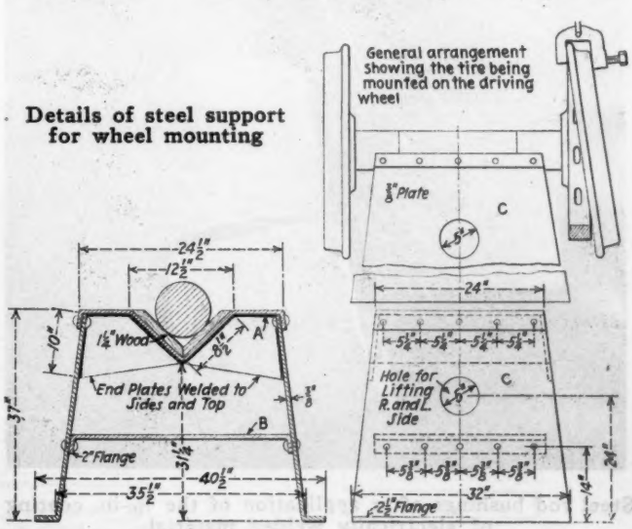
This device enables the machinist and helper to apply the valve bushing in from 12 to 15 min. and can be adjusted to suit different size valves.

A Safe Support For Mounting Wheels

IT has been the practice in some shops to use wooden "horses" for supporting driving wheels in the wheel department. A foreman on an eastern railroad has designed the metal support shown in the drawing and suggested that it is safer and more durable than one of wooden construction.

The materials used in making this support are principally scrap boiler plate of ⅜-in. thickness. The top plate *A* is bent as shown to provide a support for the driving axle and permits different size axles to be placed upon it. This angle "trough" is lined with wood 1¼-in. thick to avoid scratching the polished portion

Details of steel support for wheel mounting



of the axle. The construction of the support is such that it permits unobstructed use of the gage used for setting tires. The 5-in. hole shown in the side is for the purpose of moving the horse with the crane.

Should new plate be used a piece 48 in. by 120 in. would be required. The labor required for the fabrication of this wheel support is approximately eight man-hrs.

Reclaiming Steel Rod Bushings

WHEN the steel connecting bushings in Franklin tandem main rods work loose, it is necessary to replace them with new or reclaimed bushings which will make a tight fit in the rods and prevent pounding.

Tandem main-rod steel bushings turned to original step sizes on the outside diameter and with inside diameters trued by grinding

At the main shop on one large road, this reclamation work is handled by thoroughly cleaning each bushing, turning down the outside diameter about ⅛ in., applying a layer of 3/16 in. coated welding wire with a Westinghouse automatic welding head set up in a special engine lathe and subsequently turning down the outside diameter in three steps to the standard size required for a press fit in the main rod. The inside diameter of the bushing develops very little wear owing to the use of the floating type of bronze bushing, and, consequently, a light truing cut on a Micro internal grinder is all that is required to prepare the bushing for further service.

Steel rod bushings after application of the 3/16-in. coating of electrically welded material

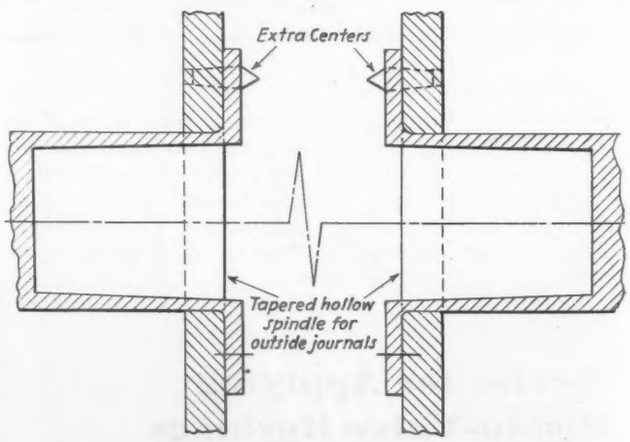
The total reclamation cost for 10 of these bushings, exclusive of any charge for overhead or stores expense, is shown in the following table:

60 hours' welding at $.85	$51.00
37 hours' machining at $.80	29.60
Annealing in the blacksmith shop	.50
Three hours' cleaning and handling	1.71
One hour's handling to and from blacksmith shop	.38
300½ lb. of welding rods at $6.43	19.32
Total	$102.51

Extra Centers on Wheel Lathe For Checking Treads

IN turning tires or wheel treads on steel car wheels, locomotive tender wheels and coach wheels, which all have outside journal bearings, the wheels are held in the wheel lathe by split collars around the journals. These collars are tapered and fit into the large hollow spindles of the lathe. (Special centers are provided to fit these large spindle holes when the lathe is used for turning engine-truck wheels having inside journals.) Experience has shown that the collars around the journals cannot always be depended on to hold the wheels central, and it is common practice to check the periphery of the wheels in another lathe to see if they are out more than 1/16 in. If they are, they are returned to the tire lathe to be turned again.

If two small lathe centers are mounted in line on the car-wheel lathe face plates, a means is provided to check these wheels for running out of true as soon as the turning job is completed, using the regular lathe hoist to place the wheels on these special centers. After the tires have been turned, the lathe is stopped with these "eccentric centers" in the uppermost position. After backing off the power-operated tailstock the wheels are raised to these dummy centers, a lift of about 8 in., and the tailstock is run in again. The tire tread is checked for concentricity by turning the pair of wheels around by hand after the cutting tool is brought up near the tread of the tire. This checking operation only takes three or four minutes after the turning is completed.

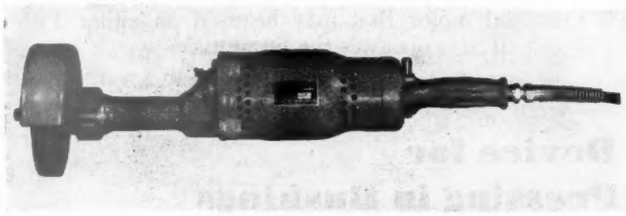


The extra centers are used instead of transferring the wheels to another lathe for checking

High Frequency Grinder

THE Buckeye Portable Tool Company, Dayton, Ohio, has just placed on the market a tool of the high-frequency electric type—the No. 61 grinder built in two speeds of 3,800 r.p.m. for use with 6-in. vitrified emery wheels and 5,400 r.p.m. for use with 6-in. elastic bonded emery wheels The lower speed tool can also be used with 8-in. elastic bonded wheels.

The features of these tools are the cool running motor, the stream-line ventilation system and the mounting of



Hercules No. 61 electric grinder

the stator on insulating pads within the motor housing, resulting in a low temperature rise in operation.

The Hercules plug-in cable is another improvement, as it makes it possible to change cables on the job instead of sending the tool to the toolroom to have a new cable installed.

Lathe Attachment For Grooving Bushings

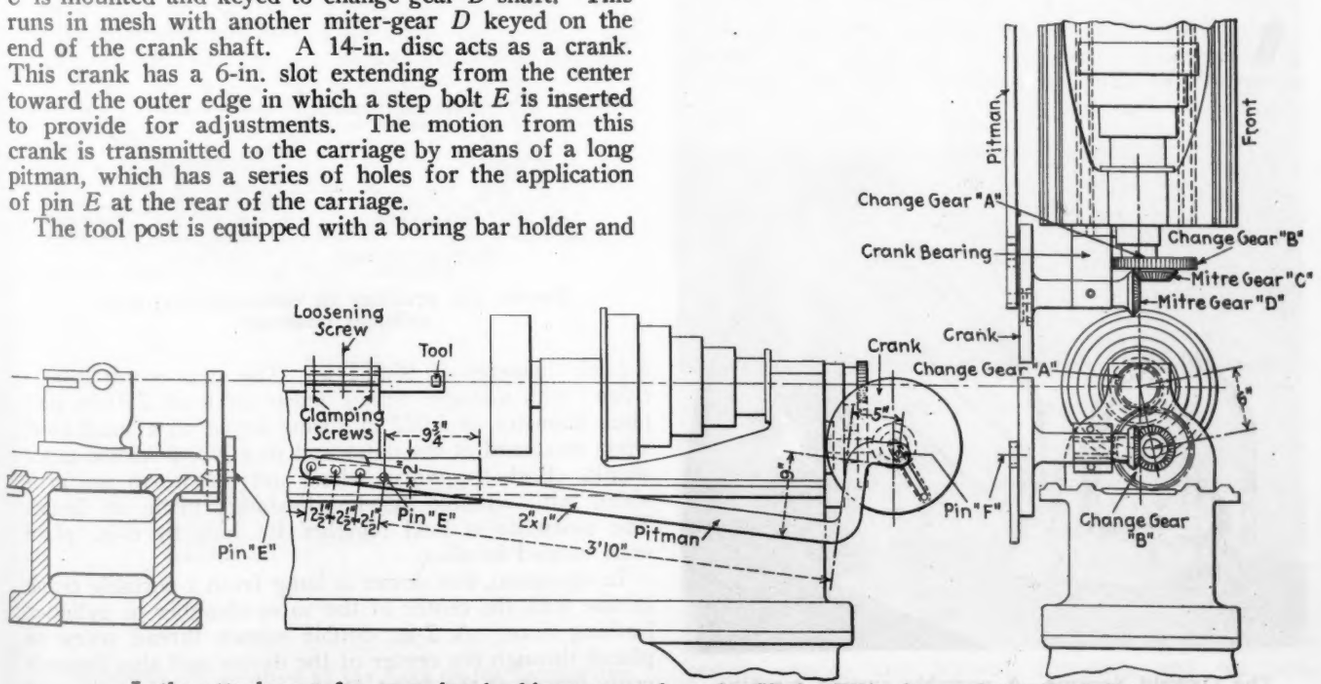
THE lathe attachment, illustrated, was developed at the Silvis (Ill.) shops of the Chicago, Rock Island & Pacific, for grooving bushings. It comprises a separate unit which can be disengaged easily from the lathe. The 32-tooth spindle gear *A* remains intact. Next a 64-tooth change gear *B* is used and a 22-tooth miter-gear *C* is mounted and keyed to change gear *B* shaft. This runs in mesh with another miter-gear *D* keyed on the end of the crank shaft. A 14-in. disc acts as a crank. This crank has a 6-in. slot extending from the center toward the outer edge in which a step bolt *E* is inserted to provide for adjustments. The motion from this crank is transmitted to the carriage by means of a long pitman, which has a series of holes for the application of pin *E* at the rear of the carriage.

The tool post is equipped with a boring bar holder and a bar with a single round nose tool for cutting the groove. The bushings are held in a universal three-jaw chuck. When operating the lathe, the bushing makes two revolutions as against one trip of the carriage in and out. This is controlled by the 2 to 1 ratio of the spindle and change gear, while the distance of the carriage travel is controlled by the adjustment of the crank, by means of the slot. The crank end of the pitman is set off center slightly less than one-half the width of the bushing so that the grooves will come near the outer edge at the bottom of the bushing. This lathe attachment produces a figure-eight groove in the bushing.

Locomotive Lifting Hook

AN ingenious and effective type of locomotive lifting hook has been developed at the Chicago shops of the Chicago & North Western, as shown in the illustration. The primary cause for the development of this device, one of which is used on each side of the locomotive at the rear for attachment to the crane equalizer and vertical side bars, is to provide greater rigidity, convenience and safety in lifting the back end of a locomotive, the front end of which is supported and lifted by the usual steel cable sling.

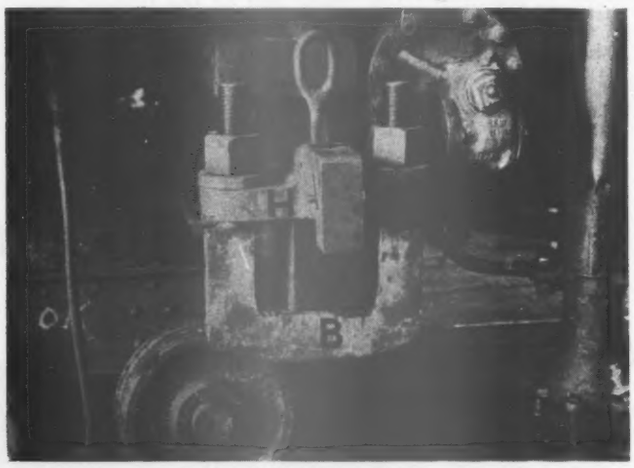
On some classes of North Western locomotives, particularly the J-4 or 2-8-4 type, the horizontal lifting beam generally used under the rear end of the locomotive cannot be put in place until the drawbars, tank hose, booster pipes, injector pipes and other connections are removed, involving a considerable amount of labor. In addition, the only bearing points available on the locomotive frame are relatively close together, being spaced only about 4 ft. apart, and, consequently, when the locomotive is lifted from its wheels and moved about the shop, it has a tendency to sway slightly and create a seemingly, if not actually, hazardous condition. This difficulty is overcome by applying two lifting hooks, one on each side of the locomotive, to the cast-steel under-



Lathe attachment for grooving bushings as used at the Silvis (Ill.) shops of the Rock Island

frame where it is extended out to the full width of the locomotive cab under the rear expansion pad for jacking purposes.

Referring to the illustration, the construction of this lifting hook is apparent. The hook, itself, consists of a heavy forging which overhangs the frame a maximum of 6¾ in. and has an inside bearing of about 14 in. to

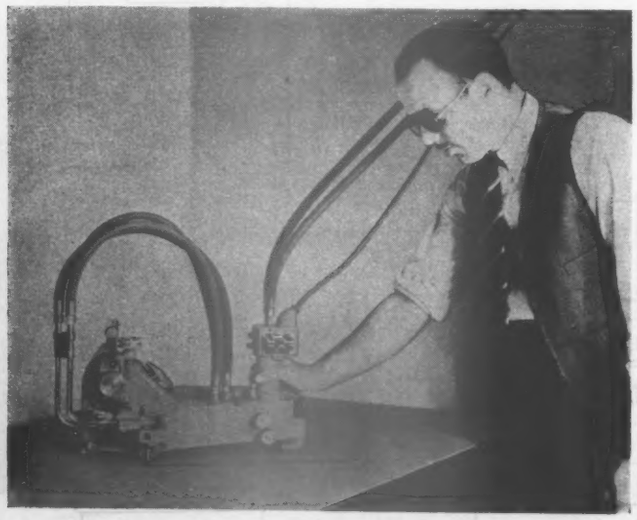


One of a pair of lifting hooks designed to replace the cross beam generally used under the rear of a locomotive when lifted by the shop crane

provide a substantial lever arm and prevent any slipping of the hook or the heavy forged-steel U-bolt, washer and nut assembly which carries the load and holds the hook firmly in place. The U section is of forged steel, roughly 4 in. square and provided with 2¾-in. standard threaded ends and nuts which are more than adequate to support the weight carried on one hook. An eye-bolt threaded into the upper part of this heavy hook facilitates applying and removing it by means of the shop crane.

Portable Cutting Machine

A PORTABLE cutting machine weighing but 43 lb. has been announced by the Linde Air Products Company, 30 East Forty-second street, New York. It is known as the Secator.



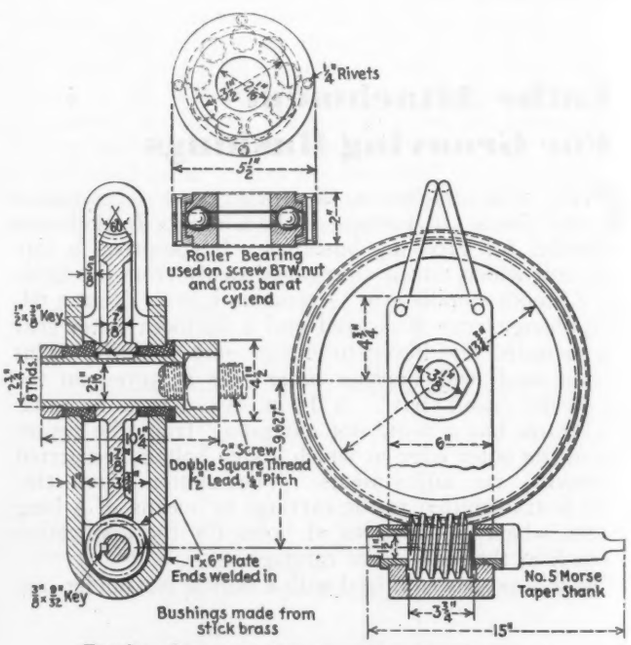
The Oxweld Secator—A portable cutting machine

Essentially, it consists of an Oxweld type C-14-H blowpipe (especially designed for it) mounted on an electrically driven, air-cooled, dust-proof chassis. It is equipped with a direct drive and runs either on a 1½-in. angle-iron track, furnished with it, or on any smooth plate. When operated on the track it does straight-line cutting automatically. For cutting simple shapes it can be guided with a hand grip. For automatic circle cutting a center and a radius rod are furnished. For convenience of control the oxygen and acetylene valves are on the chassis rather than on the blowpipe. The blowpipe can be adjusted vertically and horizontally and also to cut bevels up to 45 deg. Its cutting range is that of the C-14 blowpipe.

A universal motor that may be used on either 110- or 220-volt circuits operates the Secator.

Device for Pressing in Bushings

AN effective pneumatically-operated worm screw device for pressing in piston valve chamber and cylinder bushings is shown in the illustration. It consists of a suitable housing designed to be supported by means of two swing links from a crane and provided with a worm wheel arrangement, as illustrated. The worm wheel has a circular pitch of .750 in., 68 teeth and



Device for pressing in valve-chamber and cylinder bushings

a pitch diameter of 16.233 in. The steel worm is machined with a single thread, linear pitch of .750 in. and pitch diameter of 3.022 in., being keyed on a small steel shaft machined at the outer end to a No. 5 Morse taper shank. Both the worm wheel and the worm are provided with suitable bearing bushings made of brass. The assembly is held together by 1-in. by 6-in. plate ends welded in place.

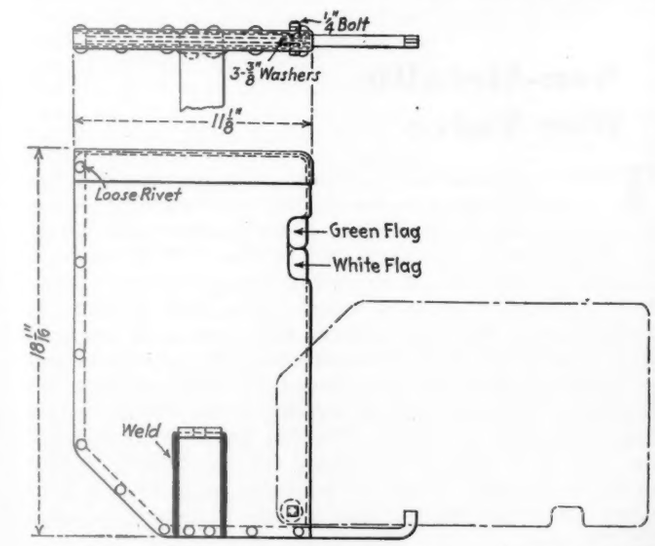
In operation, this device is hung from a portable crane in line with the center of the valve chamber or cylinder bushing bore. A 2-in. double square thread screw is placed through the center of the device and also through cross braces at the front of the cylinder and at the end

of the bushing to be pulled in. The center bushing of the device is broached to fit a hexagon nut on the screw. A roller bearing, also shown in the drawing, is used between the nut and the cross bar to reduce friction. The worm shaft is driven by an air motor applied to the No. 5 Morse taper shank on the worm shaft.

Metal Classification Flags

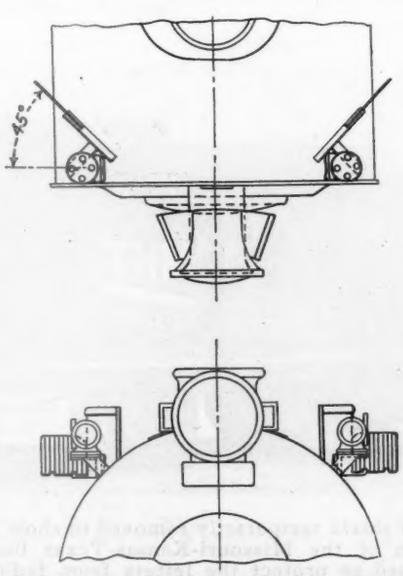
FOR the past several years one of the large eastern railroads has been using metal classification flags on its locomotives instead of the conventional flags.

The metal flags are contained in steel cases which are fastened permanently to the locomotive, being bolted



Assembly of flag case showing one flag in service position

to the classification lamp brackets. When signals are required the proper flags are withdrawn from the cases and set in place. These flags are always at the front of the locomotive where needed, are easily cleaned and there is no possibility of dropping one while it is being arranged



This shows the location of the flags on the locomotive

in place. They are highly visible due to their extended position.

The accompanying drawings show how the flags are pivoted in the case and, when in a signaling position, rest upon a support which is an extension of the case frame. The case is fitted with a cover which retains the concealed flag or flags within the case and excludes cinders. The case and the two flags—one green and one white—are made of No. 15 B.W.G. steel plate and enameled, the case being enameled black. The flags are pivoted on a steel bearing which is retained by a ¼-in. bolt and the cover is hinged on a loose rivet. Three ⅜-in. washers serve to space the flags on the bearing. The flags and case are recessed to permit the easy selection of the flags. The flags are arranged at an angle of 45 deg., which provides equal visibility from the front and side of the locomotive.

Precision Toolroom Surface Grinder

THE Monarch Machine Tool Company, Sidney, Ohio, has recently placed on the market a hand-feed surface grinder for precision work in the toolroom. Among the special features of this machine are automatic force-feed lubrication to all bearing surfaces except spindle bearings, ball-bearing surfaces fully protected against dirt, roller chain and sprocket for lengthwise table tra-

Monarch grinder for toolroom work

verse, and spindle-elevating hand wheel graduated in .0005 in., permitting extremely accurate setting.

The motor-driven spindle is a one-piece unit perfectly balanced with the rotor of the motor being pressed onto the spindle shaft. The spindle is mounted on ball bearings which are protected against abrasive and foreign substances. The castings used in this machine, with the exception of the cabinet base, are normalized to remove casting strains and prevent distortion and warpage.

Special care has been used in this grinder to protect all sliding surfaces from abrasives. An oil reservoir in the grinder base, supplied with a gage to show the quantity of oil, together with a high-pressure oil pump, supplies oil automatically through metering pins to all ball-bearing surfaces and parts requiring lubrication.

The construction of the spindle carrier and column bearings is such as to hold the spindle rigidly at right angles to the table and prevent movements or chatter. Should the spindle carrier need refitting in its column bearing, this could be readily taken care of, as the columns are separate units.

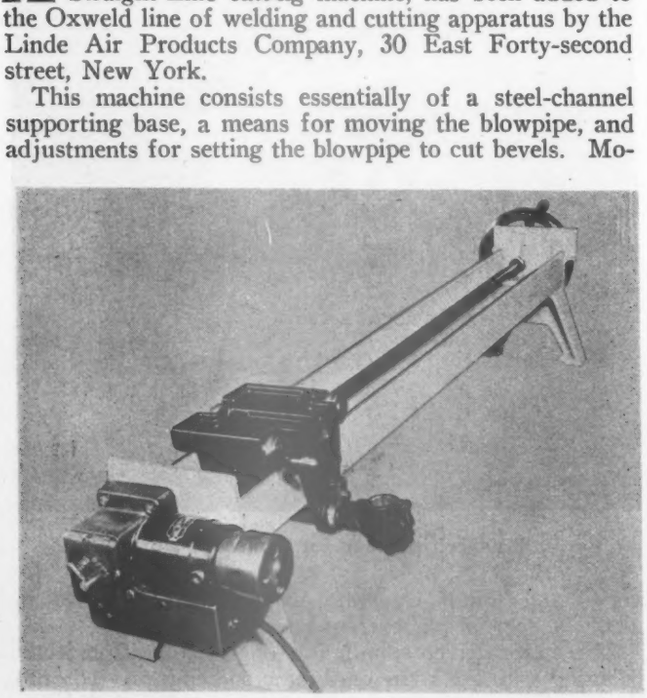
An adjustable roller chain and sprocket is used in this machine for table traverse. The chain is operated by a sprocket mounted on a splined shaft which is geared to the traverse hand-wheel shaft. One turn of a 7-in. diameter hand wheel gives 2 in. table travel. The chain is pinned to one end of the table and a convenient adjustment is provided at the other end. Both traverse and cross feed hand-wheel shafts are mounted in anti-friction bearings.

This grinder has a table travel of 18 in. and a cross-saddle travel of 6¾ in. The working surface of the table is 6 in. wide by 18 in. long. The vertical movement of the wheel spindle is 9 in. and the spindles carry a standard size 7-in. by ½-in. wheel with 1¼-in. hole. The built-in 1-hp. motor operates at a full load speed of 3,500 r.p.m. on either 50- or 60-cycle, 220-, 440-, or 550-volt current. The net weight of the machine is 1,400 lb. and it occupies a floor space 66 in. wide by 41 in. deep and has a height of 72 in.

Straight-Line Cutting Machine

A CUTTING machine, known as the Oxweld Straight-Line cutting machine, has been added to the Oxweld line of welding and cutting apparatus by the Linde Air Products Company, 30 East Forty-second street, New York.

This machine consists essentially of a steel-channel supporting base, a means for moving the blowpipe, and adjustments for setting the blowpipe to cut bevels. Motion in two directions is possible—45 in. longitudinally and 7¾ in. laterally. The machine can be furnished either with two traverse hand wheels for hand operation, or with one hand wheel and a 110-115-volt universal motor, either of which can be used by simply throwing a lever.



The Oxweld Straight-Line cutting machine

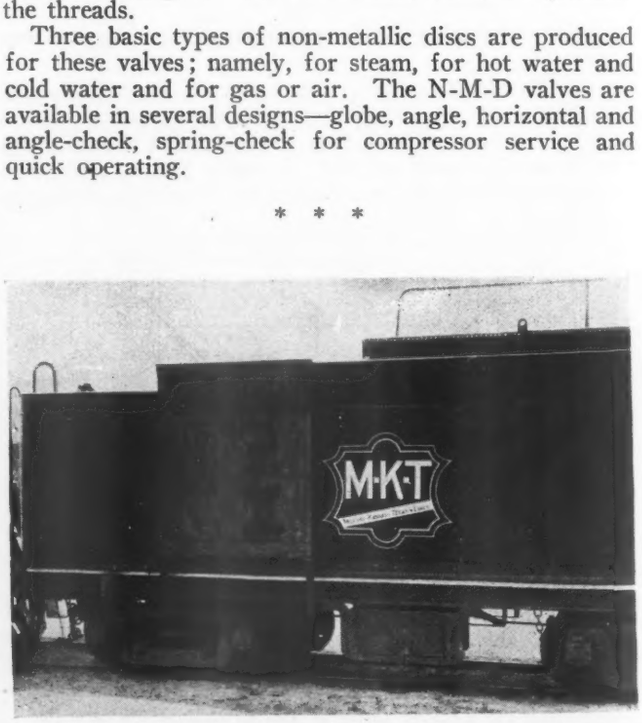
The carriage is supported by a three-point suspension and an automatic catch disengages the carriage from the worm drive when the end of the track is reached. The working parts are completely protected from dirt by a metal cover, assuring trouble-free operation. The machine has a linear speed range of up to about 33 in. per min., depending on the gear ratio specified when ordering, and has a governor graduated in inches per minute for setting the speed. A reverse switch permits motion in either direction. A straight, steady cut is assured by roller springs that keep the gears in mesh and the carriage steady. The machine is light enough to be readily portable, but bolt-holes are provided for fastening it to a permanent support if this is desired.

Non-Metallic Disc Valve

THE Lunkenheimer Company, Cincinnati, Ohio, has recently placed on the market a non-metallic bronze disc valve suitable for 150 lb. steam pressure and 300 lb. gas-liquid pressure, designated as the N-M-D valve, a feature of which is a deep stuffing box and a non-heating type malleable iron hand wheel. The stem is made of rolled bronze with long threads which are fully engaged with the threads in the bonnet when the valve is closed. A shoulder above the stem thread sits tightly against the bottom of the stuffing box, making it possible to repack the valve under pressure. The disc holder is of the slip-on type, and extra long guides are provided to insure accurate seating. Lugs are provided as a wrench hold when removing the disc and a baffle extension protects the threads.

Three basic types of non-metallic discs are produced for these valves; namely, for steam, for hot water and cold water and for gas or air. The N-M-D valves are available in several designs—globe, angle, horizontal and angle-check, spring-check for compressor service and quick operating.

* * *



Sheet-metal shield temporarily removed to show attractive red emblem of the Missouri-Kansas-Texas lines — This shield is used to protect the letters from fading by exposure to the sun during storage of the locomotive

Among the Clubs and Associations

NORTHWEST CAR MEN'S ASSOCIATION.—F. J. Swanson, general supervisor car department, Chicago, Milwaukee, St. Paul & Pacific, and past president of the Northwest Car Men's Association, presented a paper on Terminal Inspection, Repairs and Delays to Freight and Passenger Trains at the November 6 meeting of the association.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The annual meeting and election of officers of the Southern and Southwestern Railway Club will be held at 10 a.m. on November 16 at the Ansley Hotel, Atlanta, Ga. Two papers will be presented as follows: Prevention of Loss and Damage as Related to Mechanical and Operating Departments, by Joe Marshall, special representative, Freight Claim Division, American Railway Association, Chicago, and High Speed Railway Service—Its Problems and Perplexities, by L. K. Sillcox, vice-president, New York Air Brake Company, Watertown, N. Y.

CHICAGO CAR FOREMEN'S ASSOCIATION.—The Car Foremen's Association of Chicago held its annual meeting Monday evening, October 9, at the Bismark Hotel, Chicago. At the short business session, which preceded the general entertainment program provided for members of the association, their families and guests, the following officers were elected for the coming year: President, F. L. Kartheiser, mechanical inspector, Chicago, Burlington & Quincy, Chicago; first vice-president, E. Mazurette, car foreman, Grand Trunk Western, Chicago; second vice-president, C. O. Young, chief clerk, car department, Illinois Central, Chicago. Officers re-elected included the treasurer, C. J. Nelson, superintendent of interchange, the Chicago Car Interchange Bureau, and the secretary, George K. Oliver, passenger car foreman, the Alton, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The 1933 annual meeting of the American Society of Mechanical Engineers will be held December 4-8, at the Engineering Societies Building, 29 West Thirty-Ninth street, New York. A session on air conditioning will be a new feature at this meeting, the program for which, in part, is as follows:

Tuesday, December 5

9:30 a.m.

Fuels
Machine Design, Materials Handling
Railroad—I
Locomotive Counterbalancing, Lawford H. Fry
Research and Development of Light-Weight High-Speed Passenger Trains, E. E. Adams

2 p.m.

Milling vs. Planing
Applied Mechanics
Railroad—II
Research and Development of Steel for Railway Equipment
Extent to which Locomotive Standardization is Possible, H. H. Vaughan
Developments in Railroad Research
Progress in Railroad Engineering (presented by title)

8:30 p.m.

President's night

Wednesday, December 6

9:30 a.m.

Lubrication Research
Oil and Gas Power

2 p.m.

Lubrication Engineering
Railroad Service Testing of Journal Lubrication and Lubricants, Robert Job
Steam Tables Research
Heat-Transfer Symposium

6:30 p.m.

Annual dinner to new members

Thursday, December 7

9:30 a.m.

Stress Analysis
Some New Experiments on Thin-Sheet Construction, F. J. Bridget
Metal Cutting
Iron and Steel
Investigating the Performance of Bearing Metals and the Wear on These Metals, J. R. Connelly

2 p.m.

Air Conditioning
Psychrometric Investigations and Data, Dr. F. G. Keyes
Physiological Side of Air Conditioning, R. R. Sayres
Noise Elimination and Air Motion, C. B. Graves
Mechanical Springs
Analysis of Stress in a Helical Spring of Circular Wire, H. C. Perkins
Elastic Behavior and Crepe, M. F. Sayre
Fatigue and Mechanical Properties of Spring Material, D. J. McAdam
An Investigation of Eccentricity of Load in Helical Springs, J. B. Reynolds
Boiler Feedwater
Progress Report on the Determination of Dissolved Oxygen in Boiler Feedwater, C. H. Fellowes
The Solubility of Sodium Sulphate in Boiler-Water Salines as Related to the Prevention of Embrittlement, Everett P. Partridge
Engineering Education

Directory

The following list gives names of Secretaries, dates of next regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, Room 2205, 150 Broadway, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—F. W. Venton, Crane Company, Chicago.

AMERICAN RAILWAY ASSOCIATION.—Division V.—MECHANICAL.—V. R. Hawthorn, 59 East Van Buren street, Chicago.
DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorn, Chicago.
DIVISION VI.—PURCHASE AND STORES.—W. J. Farrell, 30 Vesey street, New York.
DIVISION I.—SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.
DIVISION VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Columet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W Thirty-ninth street, New York.
RAILROAD DIVISION.—Marion B. Richardson, Room 332, 30 Church street, New York.
MACHINE SHOP PRACTICE DIVISION.—R. E. W. Harrison, 6373 Beechmont avenue, Mt. Washington, Cincinnati, Ohio.
MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.
OIL AND GAS POWER DIVISION.—Edgar J. Kates, 1350 Broadway, New York.
FUELS DIVISION.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago Regular meetings, second Monday in each month except June, July and August, Bismarck Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF OMAHA, Council Bluffs and South Omaha Interchange.—Geo. Kriegler, car foreman, Chicago, Burlington & Quincy, Sixteenth avenue and Sixth street, Council Bluffs, Iowa. Regular meetings, second Tuesday of each month at Council Bluffs.

CENTRAL RAILWAY CLUB OF BUFFALO.—M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month except June, July and August, at Hotel Statler, Buffalo.

CLEVELAND RAILWAY CLUB.—F. B. Frericks, 14416 Alder avenue, Cleveland, Ohio. Meeting second Monday each month, except June, July and August, at the Auditorium Hotel, East Sixth and St. Clair avenue, Cleveland.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four building, Indianapolis, Ind. Regular meetings first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m. Noon-day luncheon, 12:15 p. m. for Executive Committee and men interested in the car department.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—T. D. Smith, 1660 Old Colony building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September. October and November meetings to be held at University Club, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meeting first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium building, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, R. F. D. 5, Peoria, Ill.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver building, Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August, Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md. Annual meeting October 17-18, Hotel Stevens, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver buiding, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

SUPPLY MEN'S ASSOCIATION.—E. H. Hancock, treasurer, Louisville Varnish Company, Louisville, Ky. Meets with Equipment Painting Section, Mechanical Division American Railway Association.

TORONTO RAILWAY CLUB.—N. A. Walford, district supervisor car service, Canadian National, Toronto, Ont. Meetings first Friday of each month except June, July and August.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

WESTERN RAILWAY CLUB.—C. L. Emerson, 822 Straus Building, Chicago. Regular meetings third Monday in each month except June, July, August and September.

NEWS

THE GREAT NORTHERN is repairing five mallet type locomotives in its own shops, the work involving the installation of new boilers.

THE HILLSBORO & NORTHEASTERN has ordered a 35-ton, 6-wheel drive Plymouth gasoline locomotive from the Fate-Root-Heath Company (Plymouth Locomotive Works).

THE WAR DEPARTMENT, United States Engineers, New Orleans, La., has ordered four asphalt cars of 20 tons' capacity. This equipment from the Atlas Car & Manufacturing Company.

E. I. DU PONT DE NEMOURS & Co. has ordered 10 special tank cars of 10,000 gal. capacity for the transportation of anhydrous ammonia from the General American Transportation Corporation. The tanks will be forge-welded and surrounded with four inches of cork insulation. The cars are now being built in General American's tank car plant at Sharon, Pa.

THE PENNSYLVANIA, effective October 16, reduced from four to two a month the number of furlough days without pay which its employees had been taking for some time past. In July of this year the furlough days were reduced to four a month from a total of six, which had been in effect since March 1. One thousand men, in addition to the 10,000 which were added since June 1, as reported in the October *Railway Mechanical Engineer*, have also been put to work by the Pennsylvania.

THE NORTHERN PACIFIC has requested bids for the immediate construction of 12 passenger locomotives. The locomotives will be of the 4-8-4, or Northern, type, and each will have a tractive power, including booster, of 82,600 lb.; the tenders will have a capacity of 27 tons of coal and 20,000 gal. of water. The total weight of each locomotive, including the tender, will be 855,000 lb. and the overall length will be 108 ft. These locomotives will be used to haul the North Coast Limited between Jamestown, N. D., and Missoula, Mont., a distance of 904 miles, without change. To prepare for the operation of these locomotives, it will be necessary for the railroad to make substantial improvements in fixed property in the district in which they are to operate. The total estimated expenditure for the locomotives and these improvements will be approximately $1,750,000.

New Research Committee of Mechanical Division

THE PLAN proposed by the General Committee of the Mechanical Division for a Committee on Research to investigate and report on problems which, in the opinion of the Division, require investigation and research, has been approved by the board of directors of the American Railway Association. The appointment of the following committee is announced by the Mechanical Division in Circular No. D.V.-808:

Harley A. Johnson (chairman), director of research, American Railway Association
E. B. Hall, general superintendent motive power and machinery, Chicago & North Western
F. H. Hardin, assistant to president, New York Central Lines
F. W. Hankins, chief motive power, Pennsylvania System
J. Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe
W. G. Black, vice-president, Chesapeake & Ohio.

After preliminary study and approval of a particular problem referred to it, the committee will set up a general plan of investigation of that problem, together with the method of procedure and estimate of cost. Existing railroad laboratory facilities will be used as far as possible and, where necessary, the committee will arrange for other facilities, such as those of railway equipment companies and universities, or will make recommendations for the equipping of the necessary laboratory by the American Railway Association.

Each project for research and investigation will be handled separately, with its own budget, which will have to be justified by the results expected to be accomplished and which will be submitted to the Board of Directors in each instance for approval.

The following subjects have been selected for immediate report on plan of procedure and estimated expense:

Use of stainless steel, aluminum alloys and other alloys in locomotive, passenger- and freight-car construction.

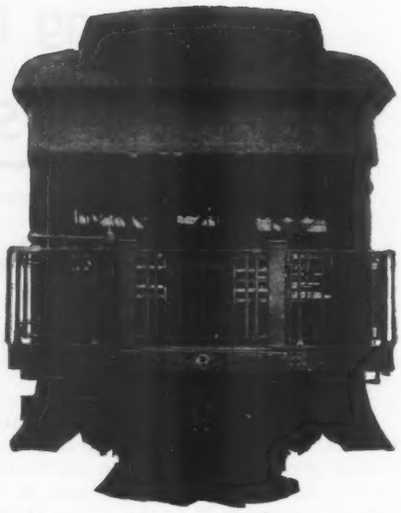
Streamlining of high-speed passenger trains.

Refrigerator car design—Economics of fundamentals of a refrigerator car.

Air conditioning of passenger cars.

Study of economics in freight-car dimensions and capacities.

Other subjects which have been selected for future consideration are: Gas-electric and other types of motor rail cars. (This subject is being handled for the present by the Committee on Automotive Rolling Stock.)



Counterbalancing of locomotives—Relation of locomotive design and operation to track structures. (This subject is being handled for the present by the Committee on Locomotive Construction.)

Containers and container cars.

Combination vehicles designed for use on highways and rails.

Self-clearing cars for bulk loading.

Roller bearings for railroad equipment. (This subject is being handled for the present by the Committees on Locomotive Construction and Car Construction.)

High-pressure locomotive boilers. (This subject is being handled for the present by the Committee on Locomotive Construction.)

Oil-electric locomotives. (This subject is being handled for the present by the Committee on Locomotive Construction.)

The subject of Trucks and Springs To Promote Easier Riding and Reduce Harmonic Spring Action is being handled by the Committee on Car Construction and road and laboratory tests are under way at the present time.

The automatic train-line connector investigation will continue under the direction of the Director of Research.

Committee to Advise Eastman on Labor Problems

CO-ORDINATOR EASTMAN has announced the appointment of an advisory committee in connection with his study of railroad labor problems. This committee will advise with O. S. Beyer of the co-ordinator's staff, who is handling railroad labor research and relations. The members of the committee have been gathered from some of the leading universities and colleges, the United States Department of Labor, and the Social Science Research Council. All have agreed to serve on the committee without compensation.

Those who have agreed to serve on the advisory committee are as follows: Dr. J. Douglas Brown, director of the Industrial Relations Section, Princeton University; Dr. Meredith B. Givens, secretary for industry and trade, Social Science Research Council; Dr. Walton H. Hamilton, professor of law, Yale University; Dr.

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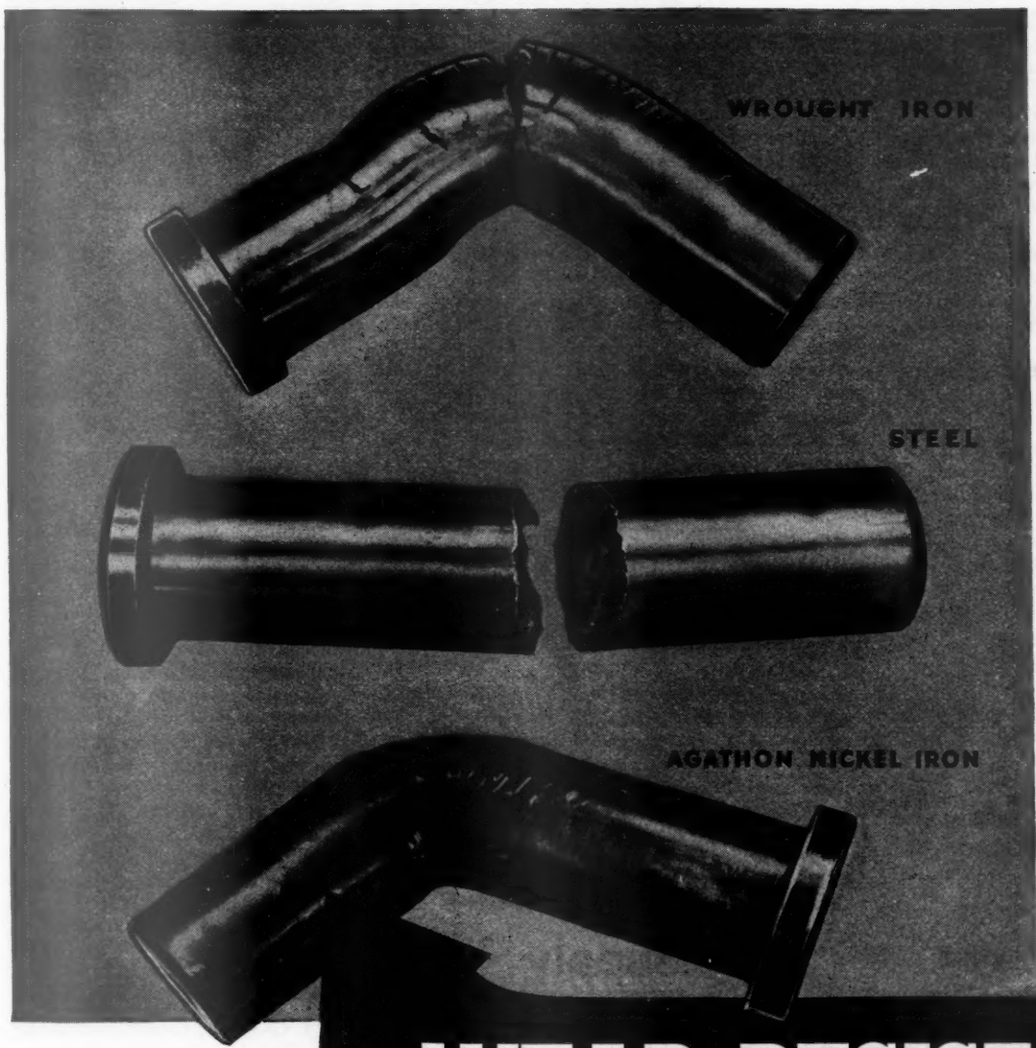


WEAR RESISTANCE

that won't crack under shock

Extremely hard surfaces for wear resistance have heretofore been brittle under shock. » » » But in Agathon Alloy Iron, Republic metallurgists have developed a material for case-hardening that has a tough core. » » » Wear resistance and shock resistance are now combined in Agathon Nickel Iron to give longer life to wearing parts and freedom from breakage. » » » Agathon Nickel Iron has a reputation for toughness. Observe the test illustrated above and note the toughness of the Agathon Nickel Iron under repeated hammer blows. » » » This modern alloy iron is ideal for all case-hardened work. There are no slag spots or seams, and warping is almost negligible. Grinding is unnecessary and the finished cost with Agathon Nickel Iron is lower. Use it for all case-hardened pins and bushings.

CENTRAL ALLOY DIVISION, MASSILLON, OHIO

REPUBLIC STEEL
CORPORATION
GENERAL OFFICES YOUNGSTOWN, OHIO

AGATHON NICKEL IRON

Toncan Iron Boiler Tubes, Pipe, Plates, Culverts, Rivets, Staybolts, Tender Plates and Firebox Sheets • Sheets and Strip for special railroad purposes • Agathon Alloy Steels for Locomotive Parts • Agathon Engine Bolt Steel • Agathon Iron for pins and bushings • Agathon Staybolt Iron • Climax Steel Staybolts • Upson Bolts and Nuts • Track Material, Maney Guard Rail Assemblies • Enduro Stainless Steel for dining car equipment, for refrigeration cars and for firebox sheets • Agathon Nickel Forging Steel.

Alvin H. Hansen, professor of economics, Employment Stabilization Research Institute, University of Minnesota; Dr. William Leiserson, professor of economics, Antioch College; Dr. Isador Lubin, United States Commissioner of Labor Statistics; Dr. David A. McCabe, Chairman, Department of Economics and Social Institutions, Princeton University; Dr. Isaiah L. Sharfman, chairman, Department of Economics, University of Michigan; Dr. Sumner Slichter, professor of business economics, Harvard School of Business Administration; Dr. William Stead, associate director, United States Employment Service.

French Railway Orders Syphons

THE LOCOMOTIVE FIREBOX COMPANY has received an order from the Paris-Orleans for 12 Nicholson thermic syphons for application to Series 4500 Pacific-type locomotives which are being converted to the 4-8-0 wheel arrangement. The first of these locomotives was syphon equipped last year and, as a result of satisfactory service tests, syphons will be installed in the 11 additional locomotives now being rebuilt. The syphons will be manufactured by the Compagnie Generale de Construction de Locomotives, Paris, and will be applied in the railway company shops at Tours, France. In addition to this order, the Paris-Orleans is inquiring for 20 syphons for the Series 3700 Pacific-type locomotives operated by this road. One of these locomotives was rebuilt, including the application of syphons, in 1927, and the recent inquiry will supplement orders for 22 syphons already installed in this class of power.

Labor Controversy Settled

CO-ORDINATOR EASTMAN on October 5 announced the settlement of a controversy between the Pere Marquette and its shop and office employees, concerning the right of employees to organize under the provisions of the Emergency Transportation Act, 1933. He made public correspondence showing that as a result of a conference held in his office on October 2 in the matter of complaints presented by the Brotherhood of Railway and Steamship Clerks, and the American Federation of Labor, Railway Employees Department, that influence was exerted in connection with the formation of the so-called Pere Marquette General Office Employees Association and the Pere Marquette Shop Crafts Association, it was agreed that all employees affected be given notices that the company would not interfere in any way with the organization of its employees. The notices, addressed to all mechanical department officers and shop craft employees and to all officers and general office employees, quoted from the language of a statement issued by Mr. Eastman on September 7 to the effect that "managements must keep their hands off, so far as labor organizations are concerned," with the added statement that "employees may refrain from joining any organization if they see fit to do so." To this was added: "The management of this company declares it to be its policy to conform in all respects with the law as summarized above by the Federal Co-ordinator of Transportation. In furtherance of this policy all employees are therefore left free to join the labor organization of their choice, notwithstanding anything heretofore to the contrary," and the notice to office employees contained the further statement that "all authorizations to represent the general office clerical employees heretofore submitted to the management are hereby annulled. Within thirty days from the date hereof, or as soon thereafter as practicable, a secret ballot will be taken, in accordance with a further notice to be announced, to determine the organization which, or agent whom, the employees desire to represent them."

Mr. Eastman wrote to John C. Shields, general solicitor of the company, that he concurred in and approved the settlement of the controversy that had been made.

Co-ordinator Proposes Scientific Research Plan

AFTER CORRESPONDENCE with Dr. Karl A. Compton, chairman of the Science Advisory Board of the National Research Council, regarding the formation of a committee by the Science Advisory Board "to study the matter of scientific research for the railroads in conjunction with the railroad managements and the Co-ordinator's organization and, if it thereafter seems expedient, to formulate a plan for carrying on such research, to assist in the initiation of the project and to advise in connection with its subsequent operation," Co-ordinator Eastman has requested the three Regional Co-ordinating Committees of the railroads to appoint a committee of railroad officers to collaborate and co-operate with the committee appointed by Dr. Compton with the following members:

Dr. F. B. Jewett, vice-president, American Telephone & Telegraph Company; president, Bell Telephone Laboratories, Inc.; *Chairman.*

Maurice Holland, director, Division Engineering and Industrial Research, National Research Council; *Director.*

Dr. C. F. Kettering, vice-president and director, General Motors Corporation; president, General Motors Research Corporation.

Dr. John Johnston, director of research, U. S. Steel Corporation.

Dr. Francis C. Frary, director of research, Aluminum Company of America.

Dr. E. K. Bolton, chemical director, E. I. du Pont de Nemours & Co.

Dr. Harold G. Moulton, president, Brookings Institution.

Professor D. C. Jackson, head of the department of electrical engineering, Massachusetts Institute of Technology, and formerly head of the engineering firm of Jackson & Morley.

R. L. Lockwood, director, Section of Purchases, office of Federal Co-ordinator of Transportation.

Dr. Isaiah Bowman, chairman, National Research Council, ex-officio member.

Mr. Eastman said that the railroads have done and are doing much in the way of research and that it may be that they are doing all that can be done; but the need is very great, and the appointment of the committee by the Science Advisory Board furnishes an opportunity to put this question to the test under most excellent auspices.

Supply Trade Notes

THE CHICAGO PNEUMATIC TOOL COMPANY has opened a new branch office at 1028 Sixth avenue south, Seattle, Wash., with A. M. Andresen as manager.

W. H. ELLIOTT has been appointed publicity representative of the Union Switch & Signal Company and the General Railway Signal Company, with headquarters at 347 Madison avenue, New York City.

DAVID FINDLAY has been elected a vice-president of the L. S. Starrett Company, Athol, Mass. Mr. Findlay will continue also as general sales manager, in which capacity he has served for many years.

A. V. GROVE of Steel and Tubes, Inc., at Cleveland, Ohio, has been transferred to the sales department at Chicago. R. E. Doyle is sales correspondent and J. F. Keeler is sales engineer, both with headquarters at Cleveland.

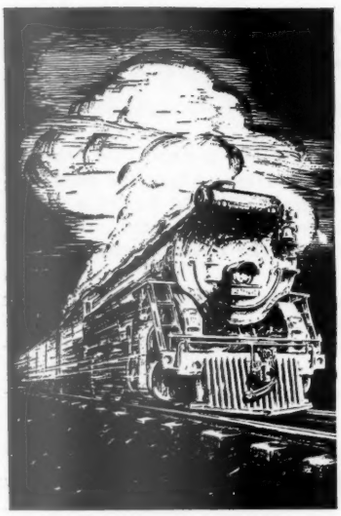
A. C. STREAMER, manager of sales of diversified products of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed also manager of transportation, with headquarters at 20 North Wacker drive, Chicago.

K. C. GARDNER, after an extended leave of absence has resumed his duties as vice-president in charge of sales of the Greenville Steel Car Company, Greenville, Pa. J. T. Brennan continues in charge of miscellaneous sales.

CHARLES J. GRAHAM, formerly president of the Bolt, Nut & Rivet Manufacturers' Association, has joined the staff of the Pressed Steel Car Company as special representative, with headquarters in the Grant Building, Pittsburgh, Pa. Mr. Graham, at the time of his affiliation with the Bolt, Nut & Rivet Manufacturers' Association which ceased to exist in May, 1931, was also vice-president of the Pittsburgh Screw & Bolt Corporation. His former company, the Graham Bolt & Nut Company, of which he was vice-president, was merged with the Pittsburgh Screw & Bolt Corporation in 1929. Mr. Graham's experience has been largely in connection with railroad sales, and his activities with the Pressed Steel Car Company will be along these lines.

HERBERT C. RYDING, since 1894 connected with iron and steel interests, now comprehended in the subsidiary companies of the United States Steel Corporation and since 1907 with the Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., in which company he succeeded as president in February, 1930, has retired under the pension rules of the United States Steel Corporation. The Finance Committee of the Corporation has recommended that Robert Gregg, vice-president of the Tennessee Coal, Iron & Railroad Company, be elected to the presidency of that company to succeed Mr. Ryding.

(*Turn to next left-hand page*)



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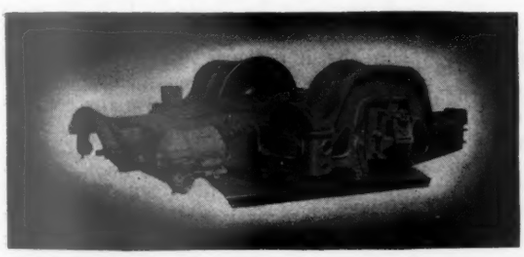

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NEW YORK CHICAGO MONTREAL

THE INLAND STEEL COMPANY, Chicago, has opened a sales office at 1511 Kirby building, Dallas, Texas. This office will have charge of sales in the state of Texas, (with the exception of the city of El Paso), and in the city of Shreveport, La. F. B. McKinney, district sales manager, is in charge of the office.

GENERAL ELECTRIC COMPANY has moved its New York offices from 120 Broadway to the General Electric building, 570 Lexington avenue. W. C. Harris has been appointed assistant engineer of the transportation department of the General Electric Company, Erie, Pa., and as such will act as a general assistant in charge of the office in the absence of H. L. Andrews.

THE AMERICAN ROLLING MILL COMPANY, Middletown, Ohio, has established a stainless steel sales department for the distribution of stainless steel sheets, strips and plates, which the company is now manufacturing, following experimental work on stainless steel alloys which has been in progress in the company's plants. J. P. Butterfield, manager of the Armco development department, has been placed in charge of the new department.

KENNETH AUBURN has been appointed district sales manager of the American Locomotive Company at New York, succeeding F. H. Reynolds. Mr. Auburn has been with the American Locomotive Company since 1920, when he started the special apprenticeship course at the Schenectady (N. Y.) works. He afterwards served as a draftsman and designing engineer and since 1927 has been attached to the sales department in the St. Louis, Mo., and New York districts.

THE LECARBONE COMPANY, with headquarters in Hoboken, N. J., has consolidated its two divisions, the Carbon Products Division and the Battery Division. H. R. Partridge, formerly manager of the Carbon Products Division, becomes general manager of the new organization with headquarters at Hoboken. B. R. Padmore becomes chief engineer with headquarters at the plant in Hoboken. The former chief district engineers of the Carbon Products Division have had their activities extended to include batteries. These include, E. C. Brehm, Chicago, W. R. Catching, San Francisco, A. M. Ramsey, Pittsburgh. P. G. Pendorf and W. R. Nelson, sales and service engineers, will continue to devote their activities to the battery field, with headquarters at Hoboken and Chicago, respectively.

Obituary

WILLIAM MCCONWAY, JR., chairman of the board of the McConway & Torley Corporation, Pittsburgh, Pa., died on October 16.

WILLIAM COYNE, vice-president in charge of sales of E. I. du Pont de Nemours & Co., with headquarters at Wilmington, Del., died on October 31, of a heart attack. Mr. Coyne was born 67 years ago at Calumet, Ind., and entered the service of E. I. du Pont de Nemours & Co. in 1904.

Personal Mention

General

C. M. HOUSE, superintendent of motive power and equipment of the Alton, has moved his headquarters from Bloomington, Ill., to Chicago.

H. W. JONES, general superintendent of motive power of the Pennsylvania at Pittsburgh, Pa., has been named general superintendent of the Southwestern division, with headquarters at Indianapolis, Ind.

M. R. REED, superintendent of motive power of the Pennsylvania at Harrisburg, Pa., has been promoted to the position of general superintendent of motive power of the Central region, with headquarters at Pittsburgh, Pa.

H. H. HAUPT, master mechanic of the central region of the Pennsylvania, with headquarters at Buffalo, N. Y., has been appointed superintendent of motive power of the Eastern and Central divisions at Harrisburg, Pa., succeeding M. R. Reed.

OTTO JABELMANN, who has been appointed assistant general superintendent motive power and machinery in charge of the car department of the Union Pacific System, with headquarters at Omaha, Neb., has been connected with the Union Pacific for 27 years. He was born on July 24, 1890, at Cheyenne, Wyo., and entered the service of the Union Pacific as a caller at Cheyenne on September 22, 1906. Subsequently, Mr. Jabelmann served as an apprentice, machinist helper, machinist and assistant enginehouse foreman at Cheyenne, general foreman at Laramie, Wyo., machinist at North Platte, Neb., and enginehouse foreman and district foreman at Cheyenne. On August 1, 1925, he was appointed superintendent of shops at Cheyenne, and on January 1, 1929, was transferred to Omaha. He held the latter position until the time of his appointment as assistant general superintendent motive power and machinery. Mr. Jabelmann's service with the Union Pacific has been continuous except for the period from May to August, 1917, when he was a machinist on the Southern Pacific at San Francisco, Cal.

Purchasing and Stores

S. A. HAYDEN, chief clerk to the general storekeeper of the Missouri-Kansas-Texas, has been promoted to general storekeeper, with headquarters at Parsons, Kan., to succeed C. L. Wright.

Obituary

R. H. FASEN, superintendent of shops on the Union Pacific, with headquarters at Cheyenne, Wyo., died on October 20.

HAROLD WILSON, assistant to the general purchasing agent of the Union Pacific System, with headquarters at Omaha, Neb., died on October 30 at St. Joseph hospital in Omaha.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

WATER-TREATING UNITS.—The Dearborn Chemical Company, Chicago, describes and illustrates in a 12-page booklet water treating units and testing equipment for boiler feedwaters in railway and stationary service.

"WELDING OF GENUINE WROUGHT IRON."—This is the title of a bulletin issued by the A. M. Byers Company, Pittsburgh, Pa., which deals specifically with the information of primary interest to the welder, fabricator and designing engineer.

GROUND THREAD TAPS.—Catalog No. 12A, superseding Catalog No. 12, has been issued by John Bath & Co., Inc., 18 Grafton street, Worcester, Mass. Among the products listed are Precision and Commercial ground hand taps, thread gages, tapper taps, pulley taps and A.S.M.E. taps.

REFRACTORY PRODUCTS.— A six-page, two-color folder, issued by the Standard Fuel Engineering Company, Detroit, Mich., describes each of the refractory products which are now sold under the trade-mark "Zero", and gives technical information on the use of refractory products in the field of high temperatures.

WELDING EQUIPMENT.—"At last automatically maintained pressure regulation" is the title of a leaflet issued by the Air Reduction Sales Company, Lincoln building, New York, in which the underlying principles of this new type of regulator are briefly described. The leaflet is printed and illustrated in four colors.

CARBON STEELS.—The Carnegie Steel Company, Pittsburgh, Pa., outlines in a 62-page treatise certain aspects of steel quality, its control in the basic open-hearth process and the importance of this control to the users and consumers of steel. Part I deals with carbon steel quality factors and the need for control; Part II, with Carnegie controlled carbon steels; Part III, with the importance of controlled steel making to the steel consumer, and Part IV, with the Carnegie system for controlling quality factors.

MOTOR MECHANICS' HAND BOOK.—A 32-page booklet, Hand Book No. 33, showing the latest practical methods for handling major maintenance jobs encountered in keeping up such equipment as tractors, trucks, automobiles, power shovels, gasoline and Diesel engines, pumps and general mechanical equipment, has been issued by the Technical Service Department of the South Bend Lathe Works, South Bend, Ind. Other data includes information on selecting a lathe and shop equipment, servicing equipments recommended for various sizes and types of shops, etc.